ViaSat
Government Systems

Testing Complex Communication Systems in a Virtual Environment

Manuel L. Garcia – ViaSat Inc.

manuel.garcia@viasat.com

ICNS Conference – Annapolis, Maryland
May 21, 2003

Presentation Agenda

ViaSat
Government Systems

- Brief History of the Joint Communication System (JCS) Development
- Test Philosophy For the JCS Development
- JCS Capabilities and Architecture
- Ongoing and Planned Enhancements
- Conclusion

Brief History

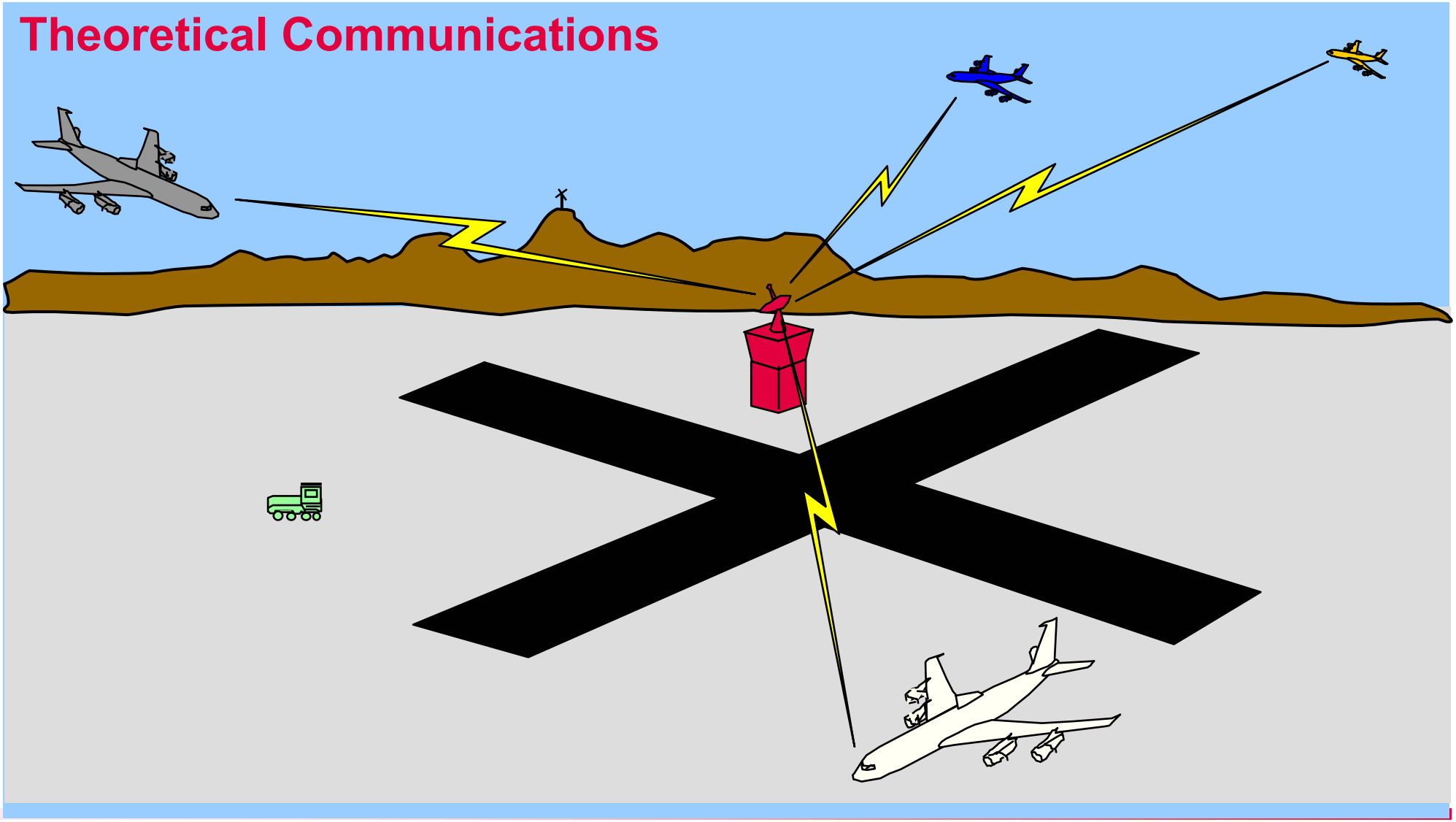
ViaSat
Government Systems

- Began Life as a Government sponsored Small Business Innovative Research (SBIR) Program in 1987
  - *Customer wanted the ability to generate any signal of interest in a real world environment with one piece of test equipment*
- Successfully Demonstrated Concept and Developed the Stimulator through Phase III
- Both Navy and Air Force Ordered a Next Generation Unit With Built in Signal Libraries and Sophisticated Flight Equations based on WGS-84 Earth
- The Joint Communication Simulator (JCS) was the result

Test Philosophy For JCS

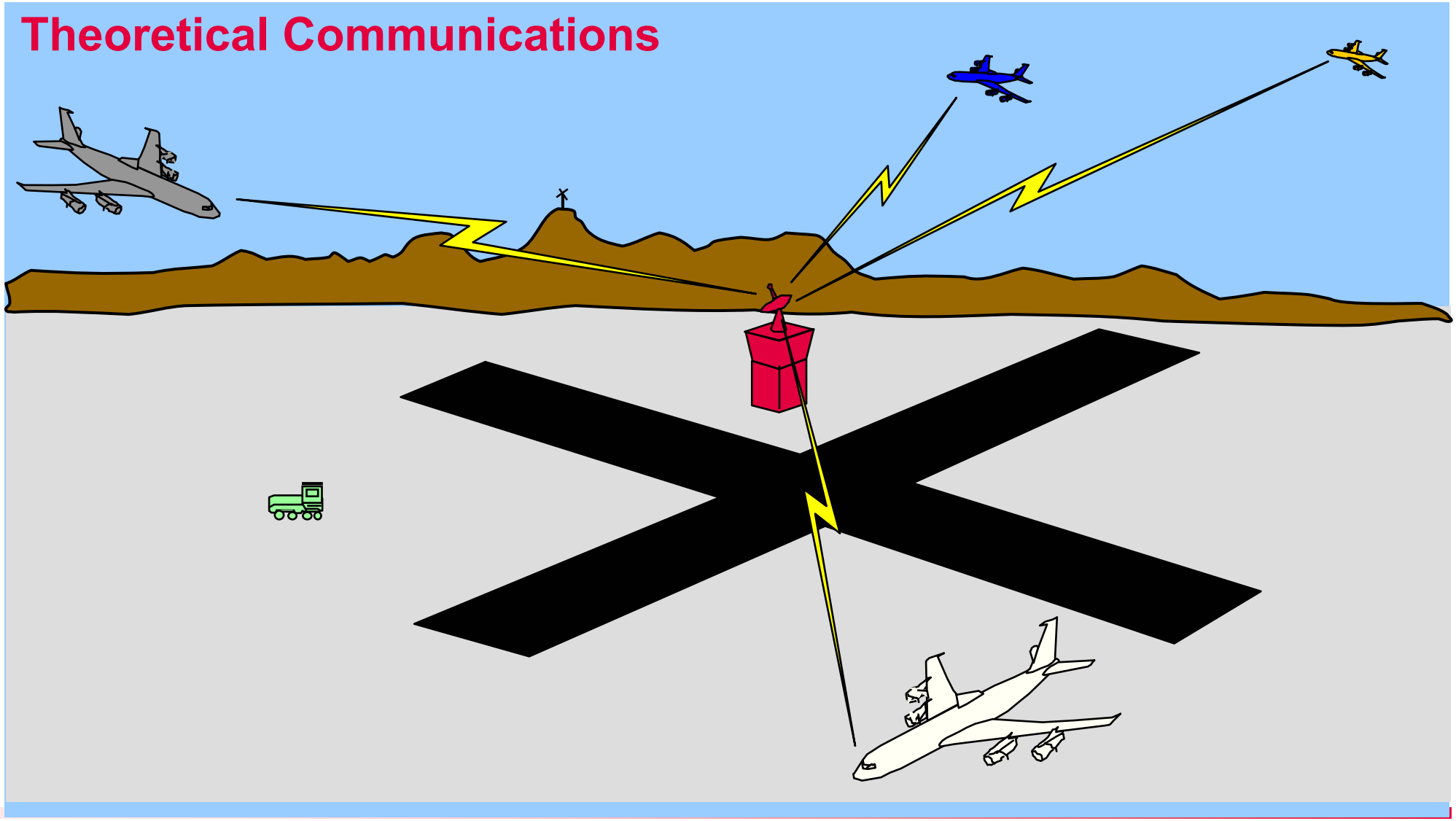
ViaSat
Government Systems

Theoretical Communications



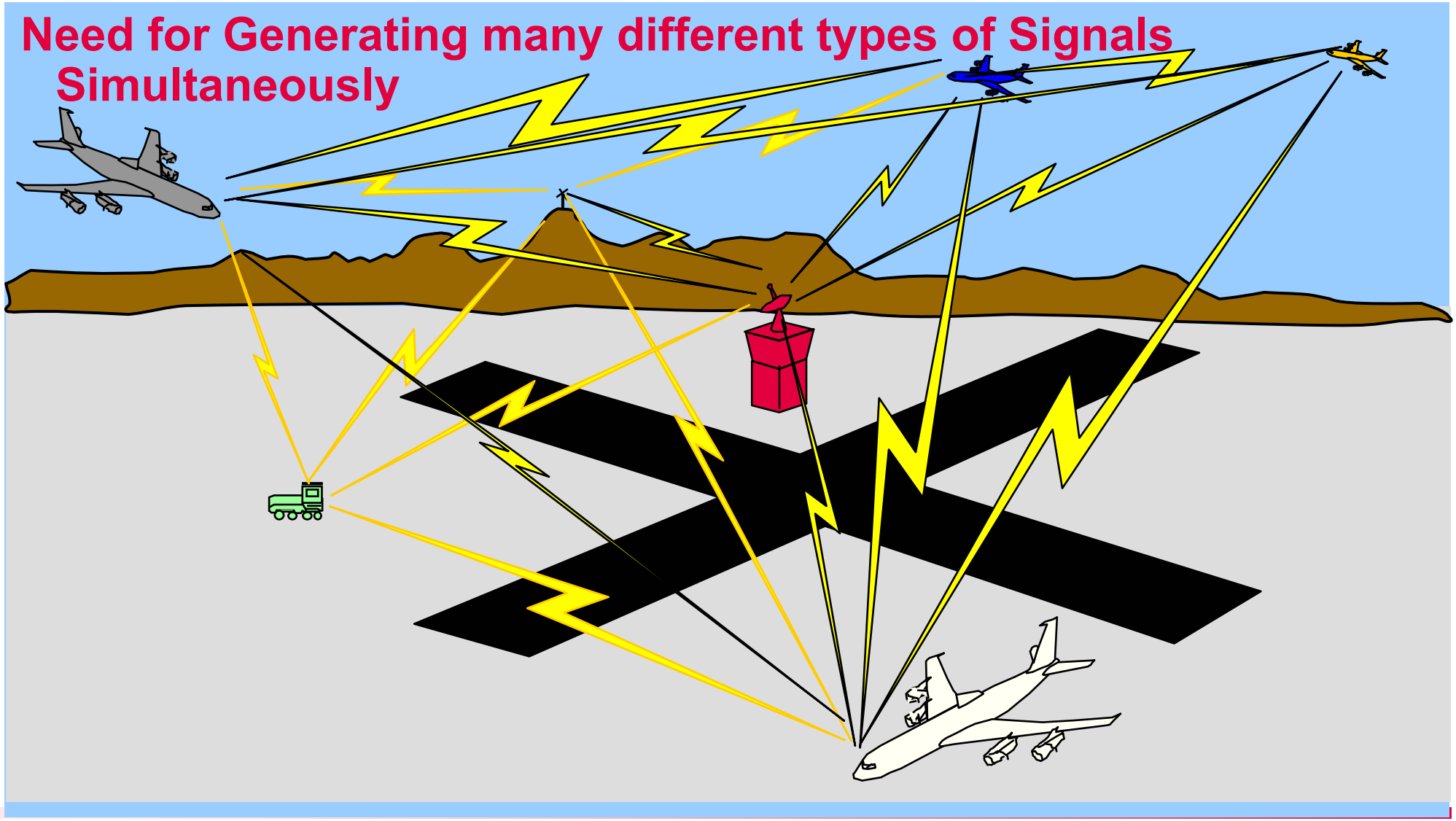
Test Philosophy For JCS

ViaSat
Government Systems



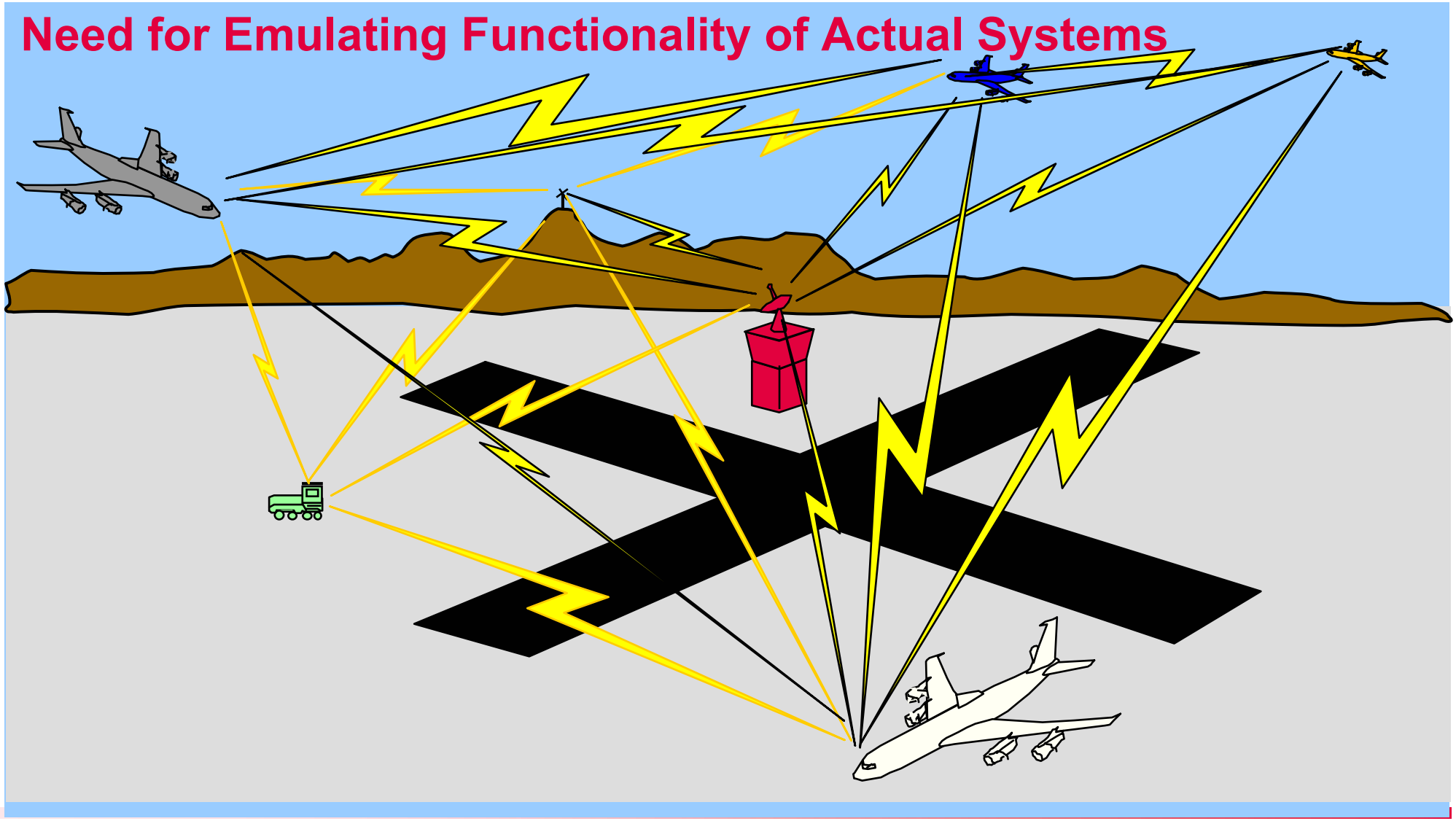
Test Philosophy For JCS

ViaSat
Government Systems



Test Philosophy For JCS

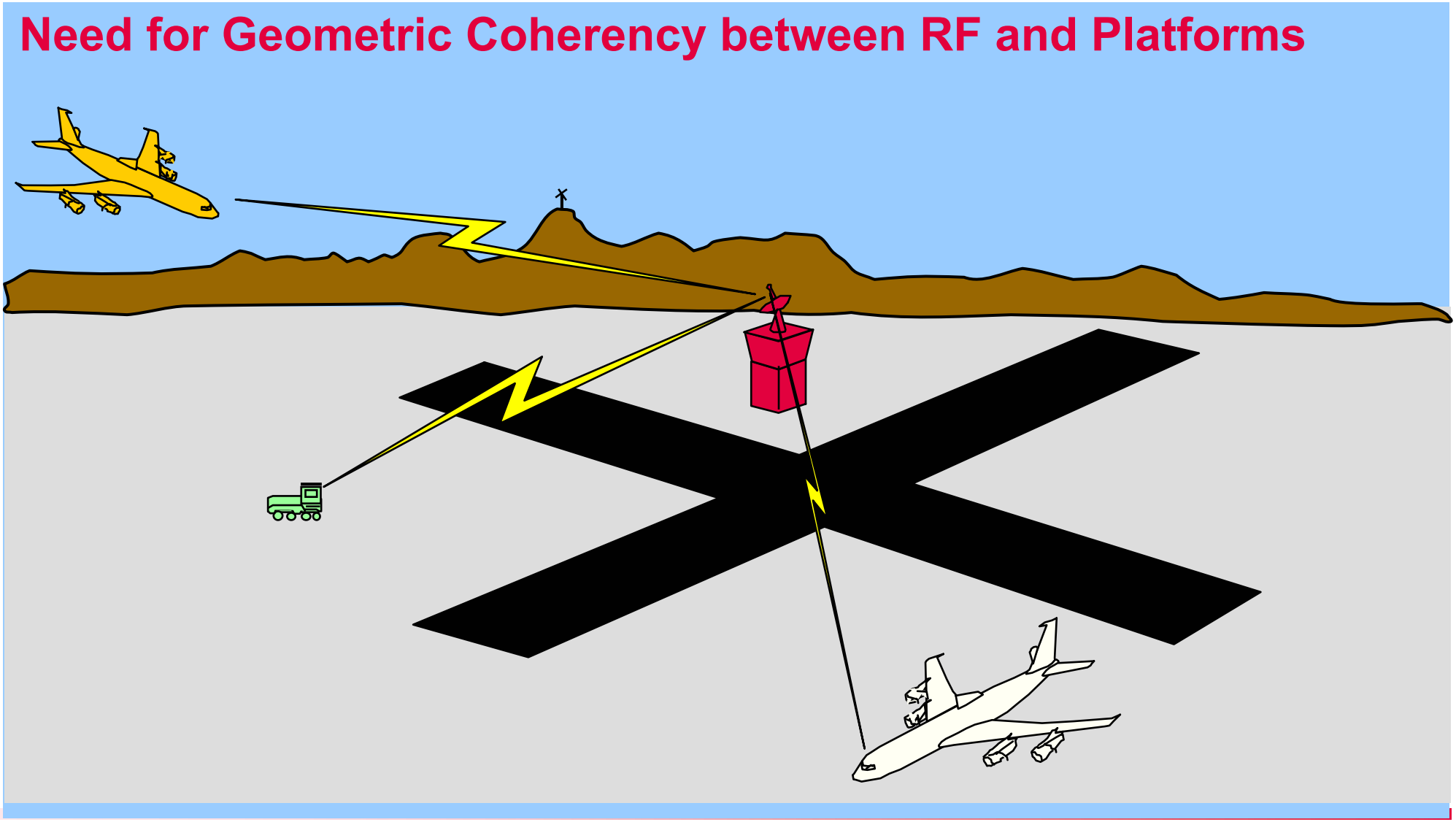
ViaSat
Government Systems



Test Philosophy For JCS

ViaSat
Government Systems

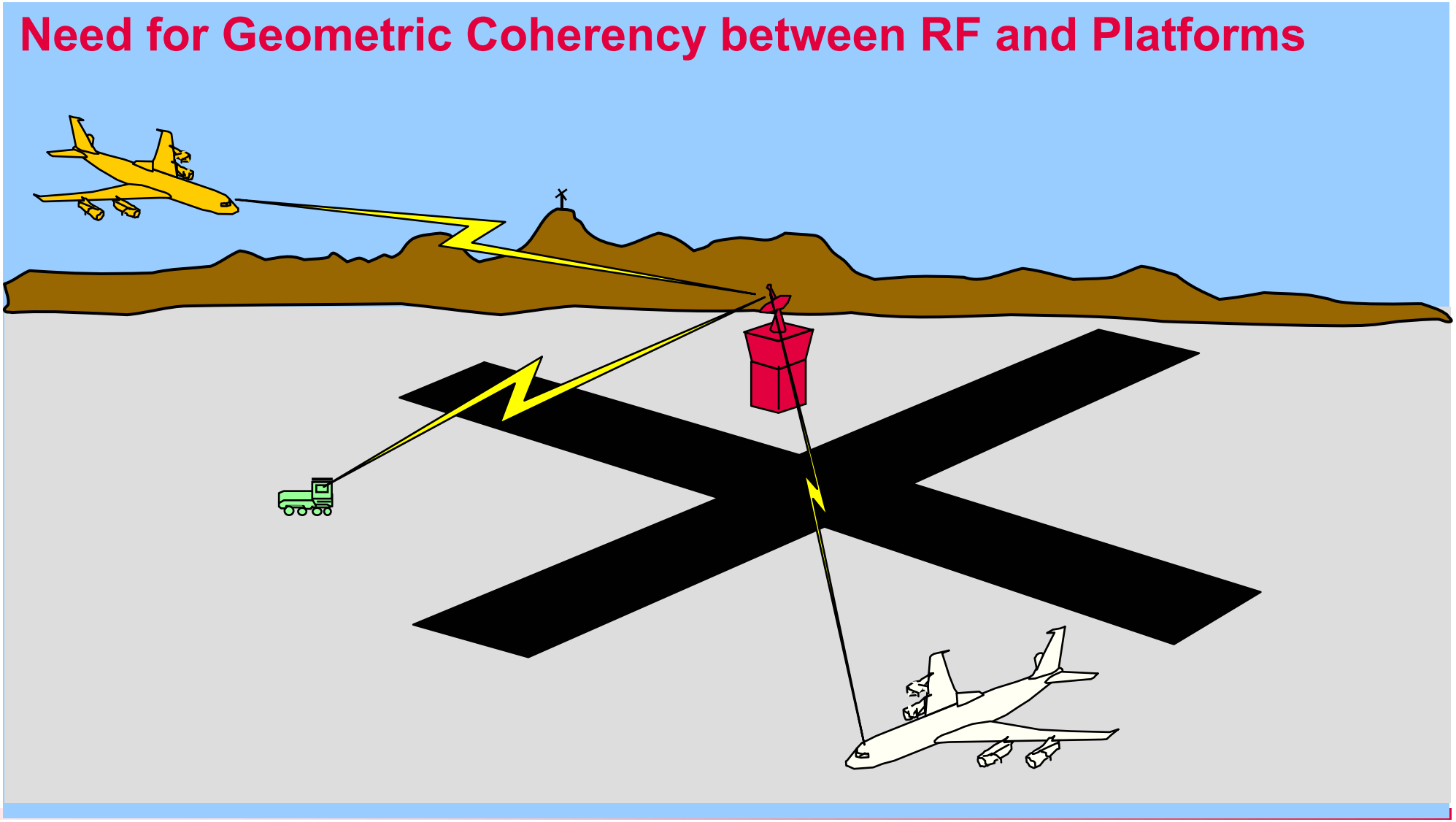
Need for Geometric Coherency between RF and Platforms



Test Philosophy For JCS

ViaSat
Government Systems

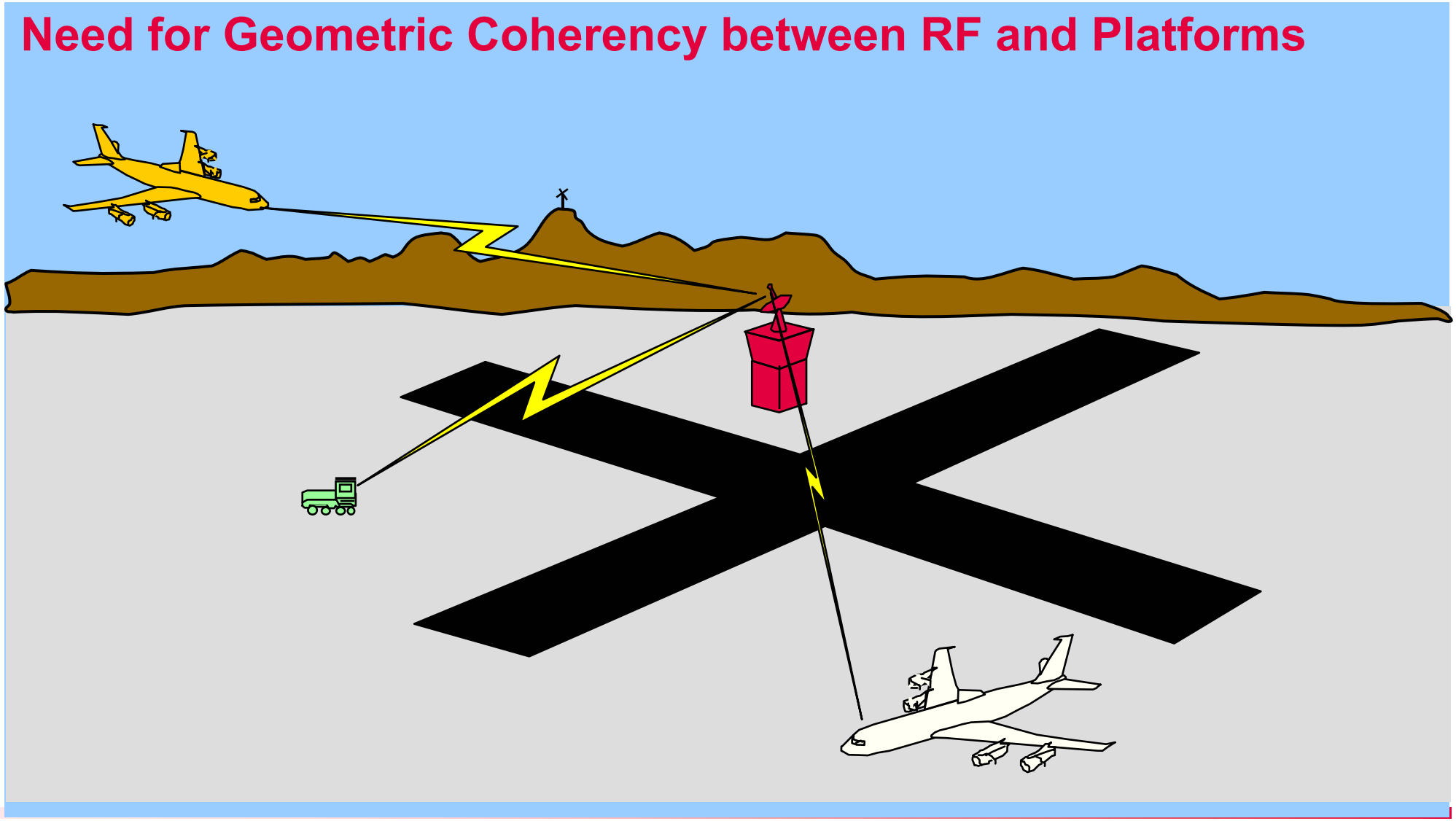
Need for Geometric Coherency between RF and Platforms



Test Philosophy For JCS

ViaSat
Government Systems

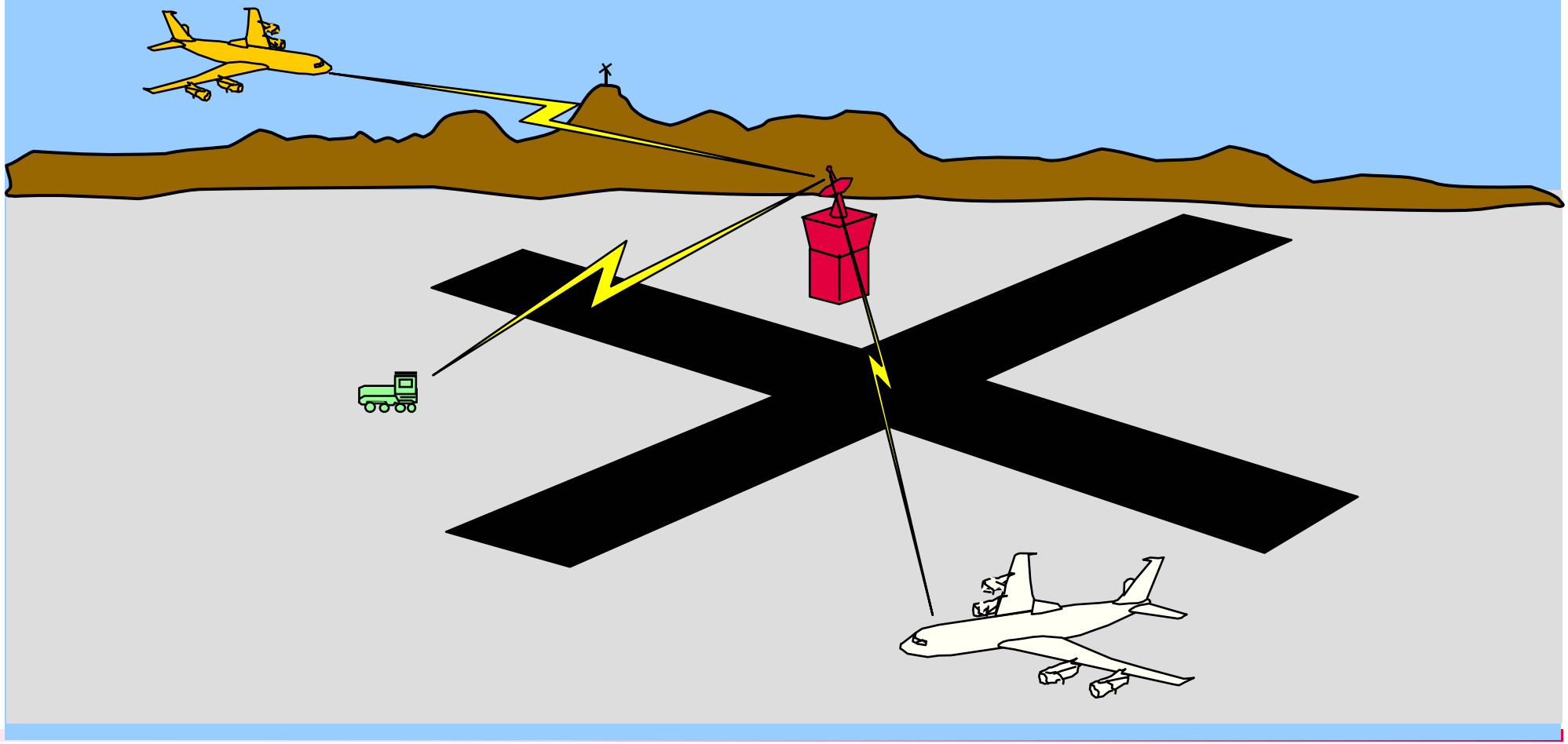
Need for Geometric Coherency between RF and Platforms



Test Philosophy For JCS

ViaSat
Government Systems

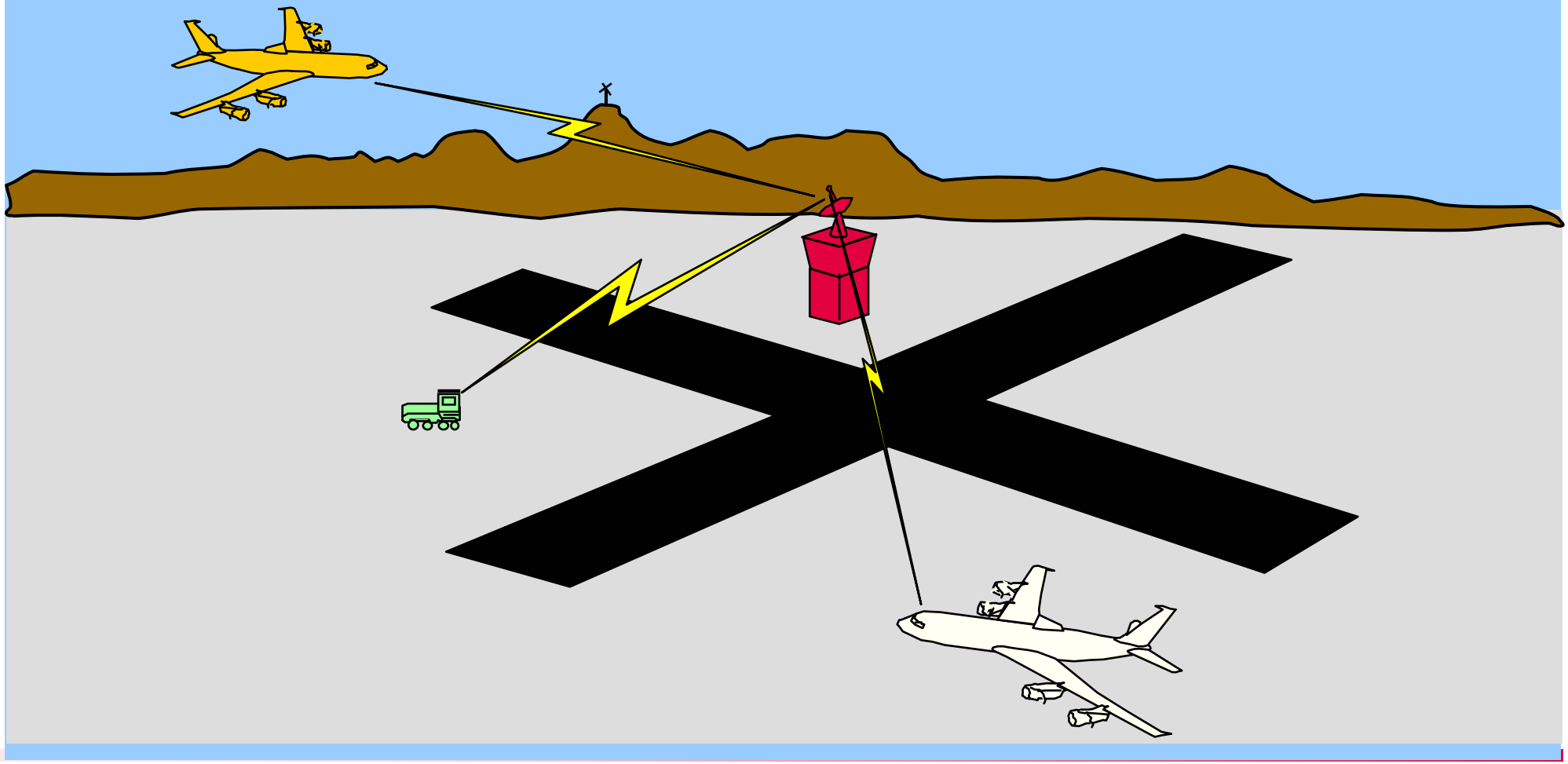
Need for Geometric Coherency between RF and Platforms



Test Philosophy For JCS

ViaSat
Government Systems

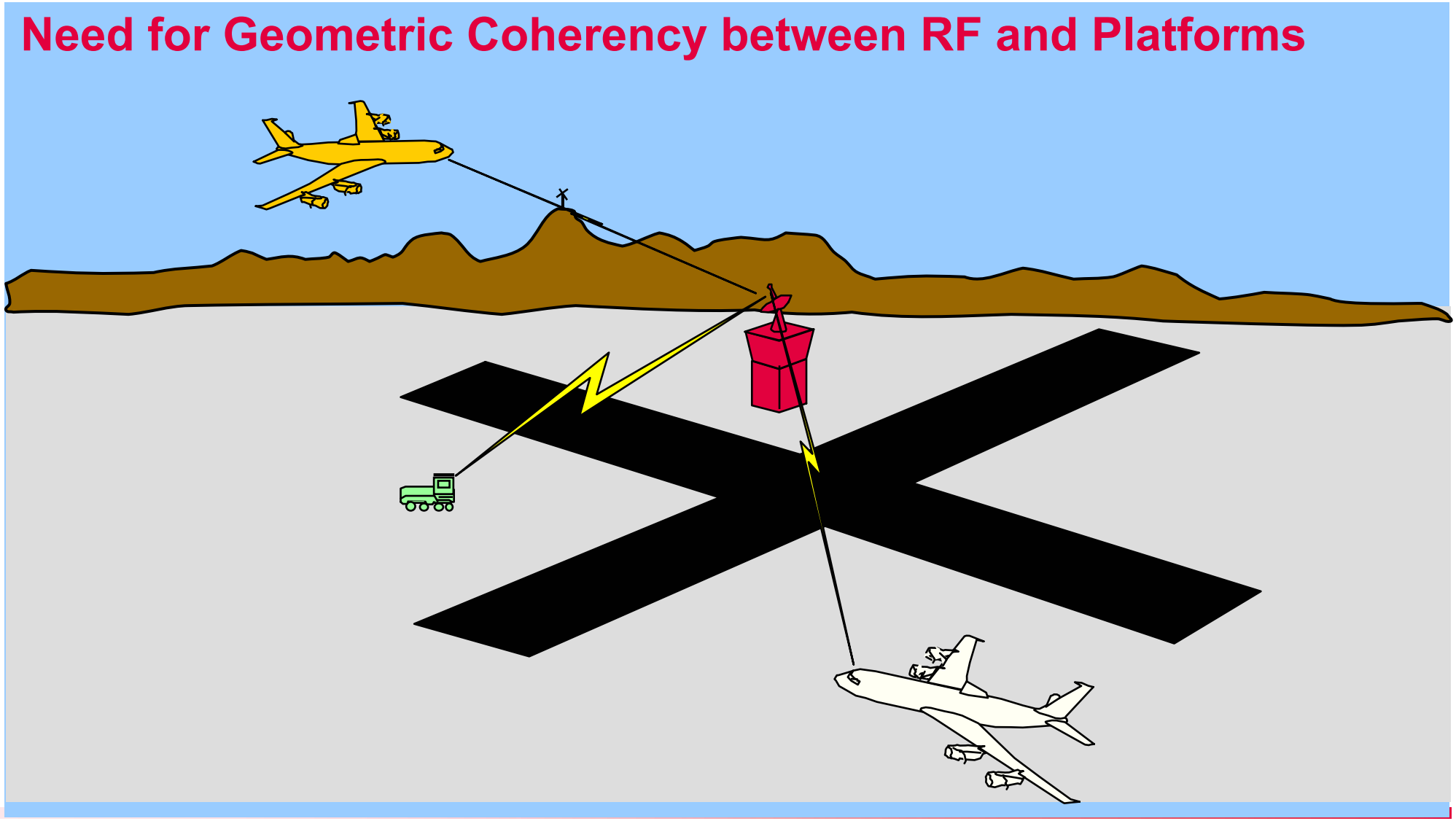
Need for Geometric Coherency between RF and Platforms



Test Philosophy For JCS

ViaSat
Government Systems

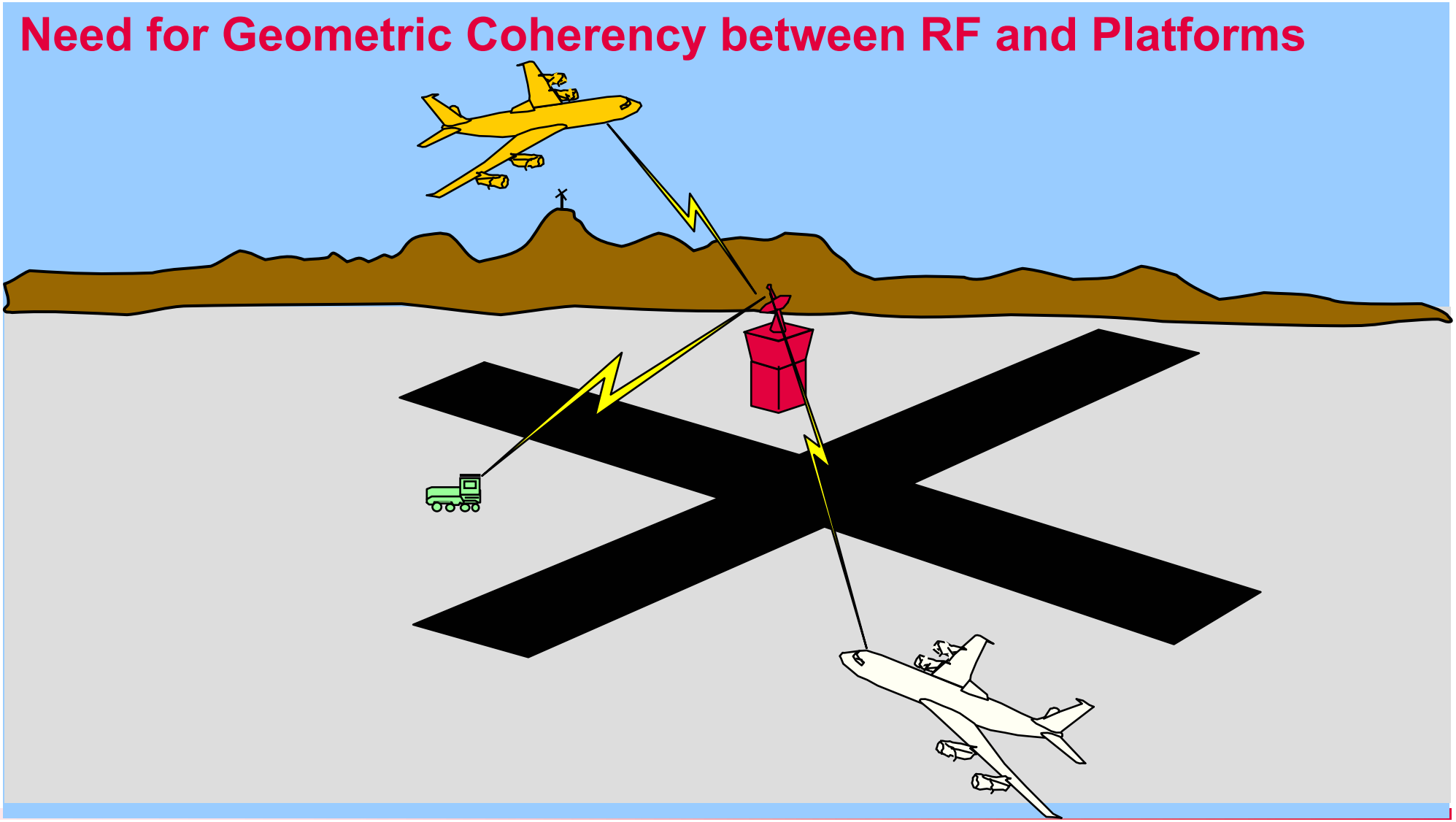
Need for Geometric Coherency between RF and Platforms



Test Philosophy For JCS

ViaSat
Government Systems

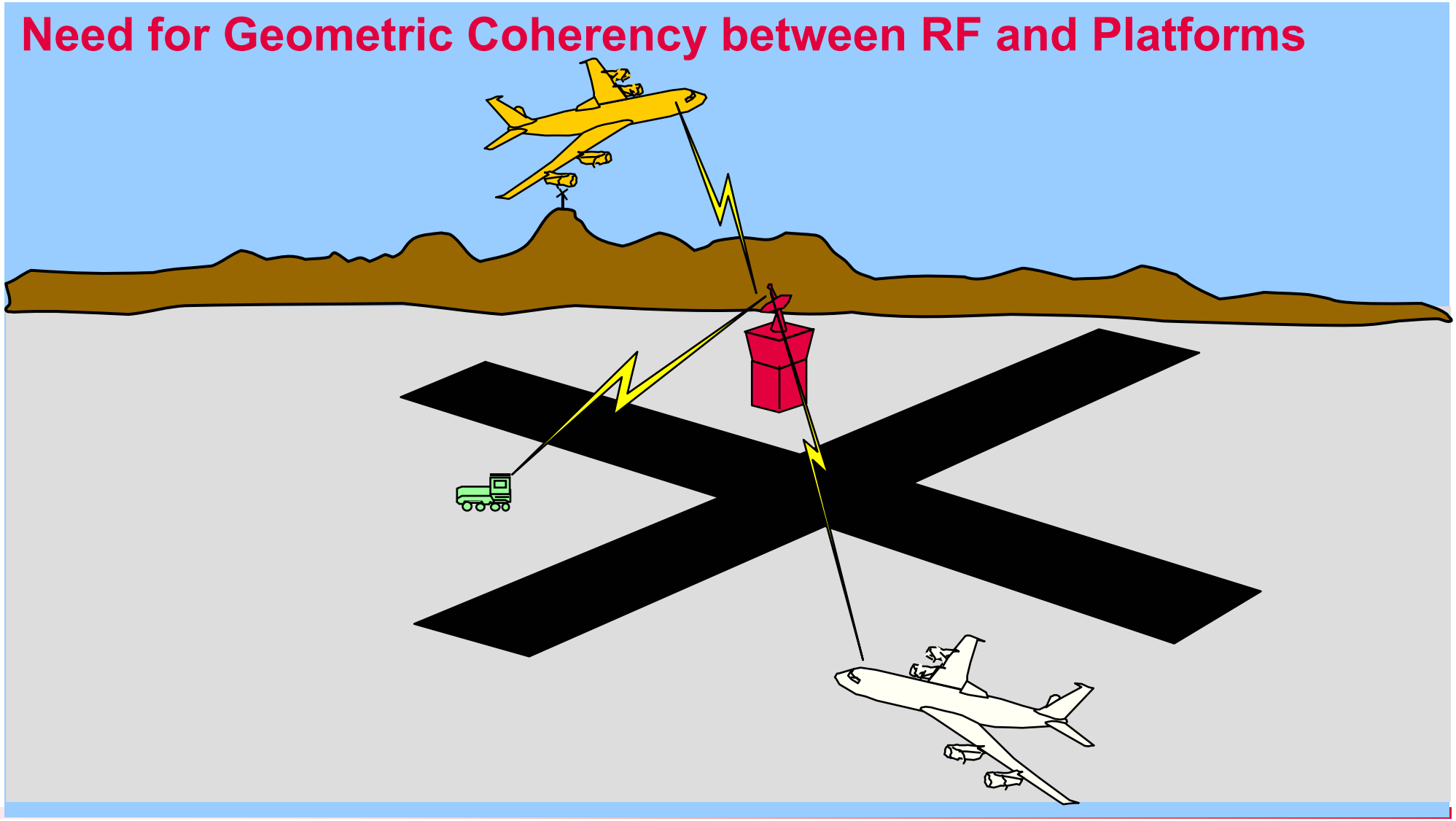
Need for Geometric Coherency between RF and Platforms



Test Philosophy For JCS

ViaSat
Government Systems

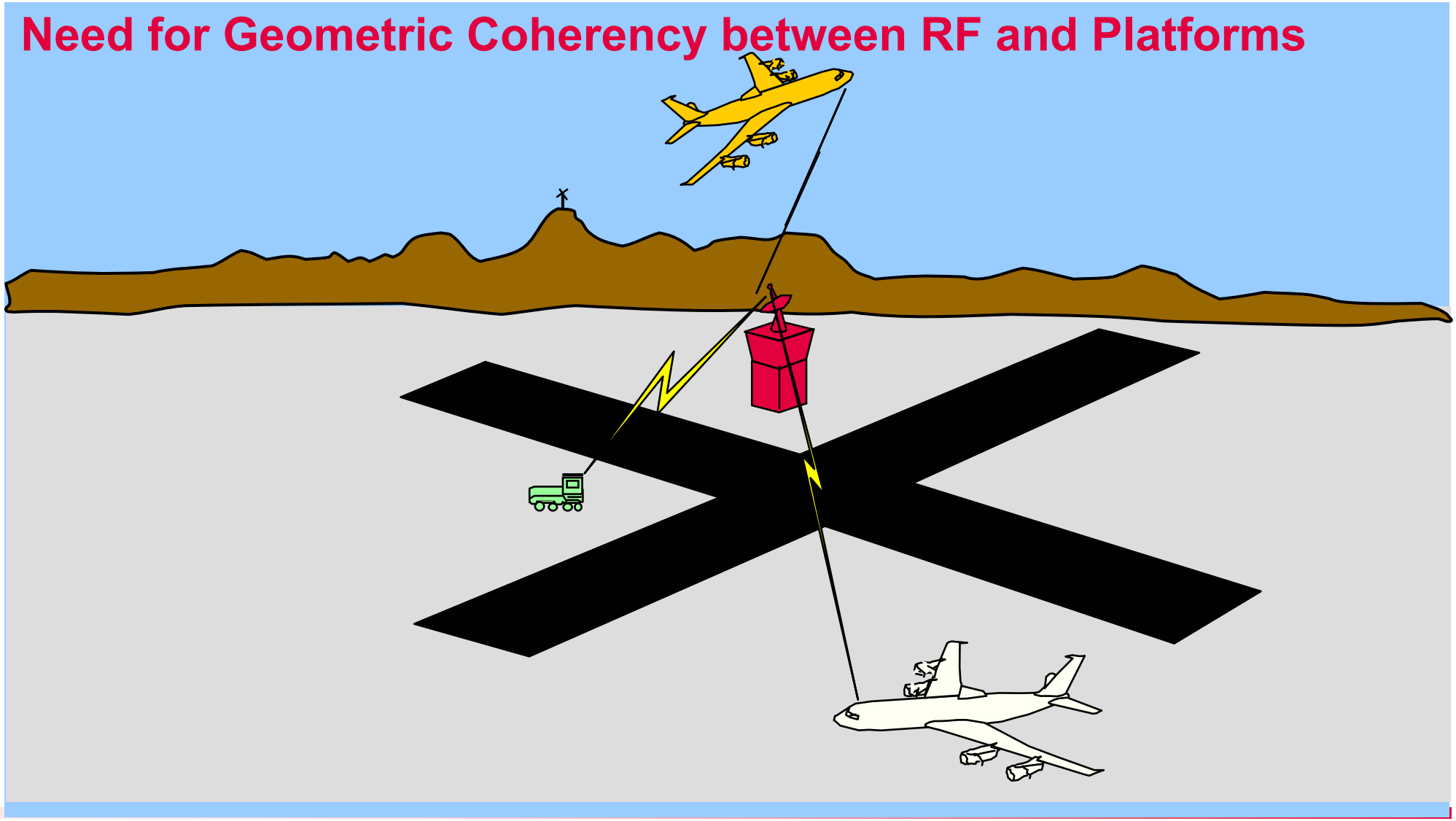
Need for Geometric Coherency between RF and Platforms



Test Philosophy For JCS

ViaSat
Government Systems

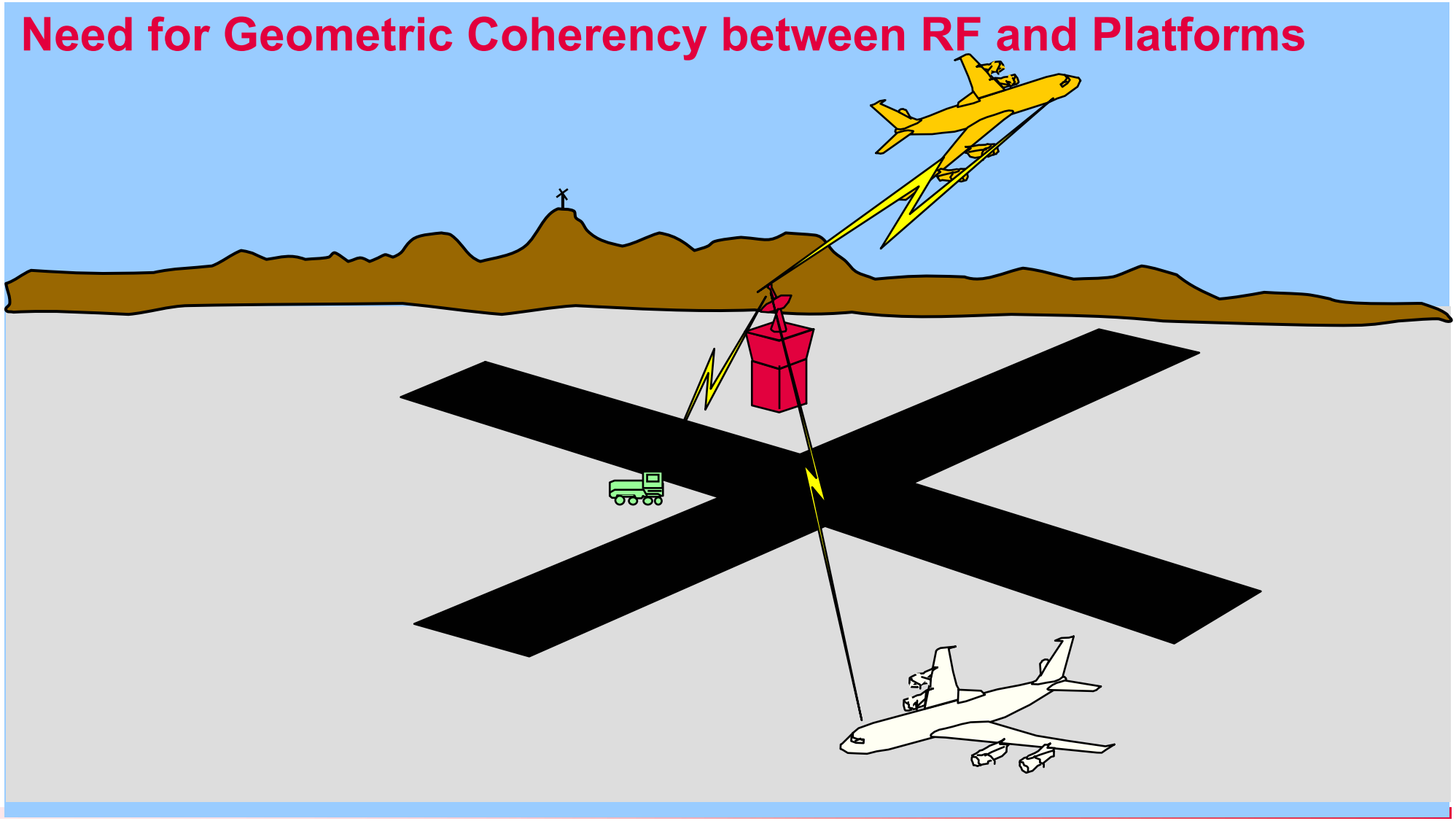
Need for Geometric Coherency between RF and Platforms



Test Philosophy For JCS

ViaSat
Government Systems

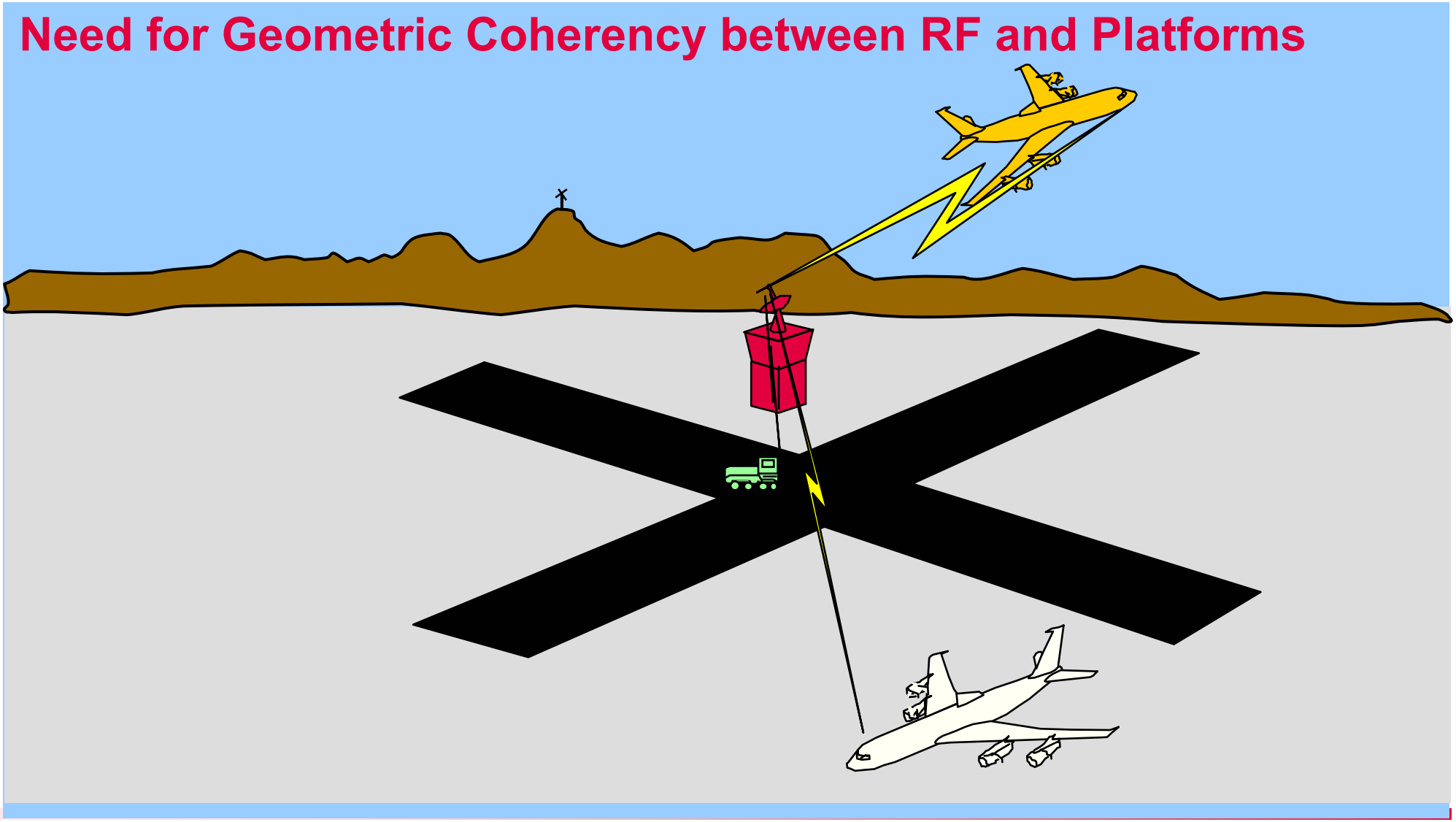
Need for Geometric Coherency between RF and Platforms



Test Philosophy For JCS

ViaSat
Government Systems

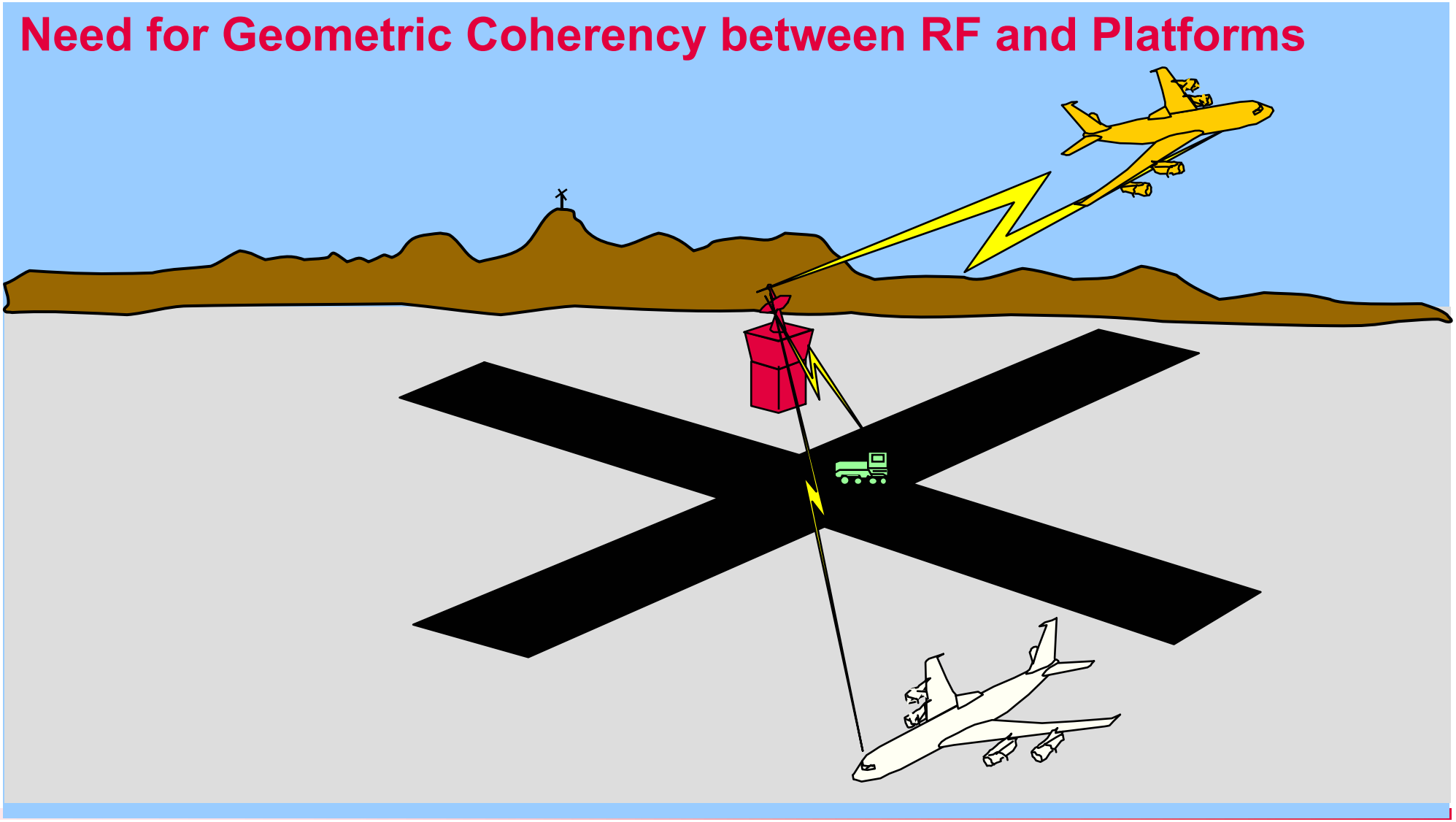
Need for Geometric Coherency between RF and Platforms



Test Philosophy For JCS

ViaSat
Government Systems

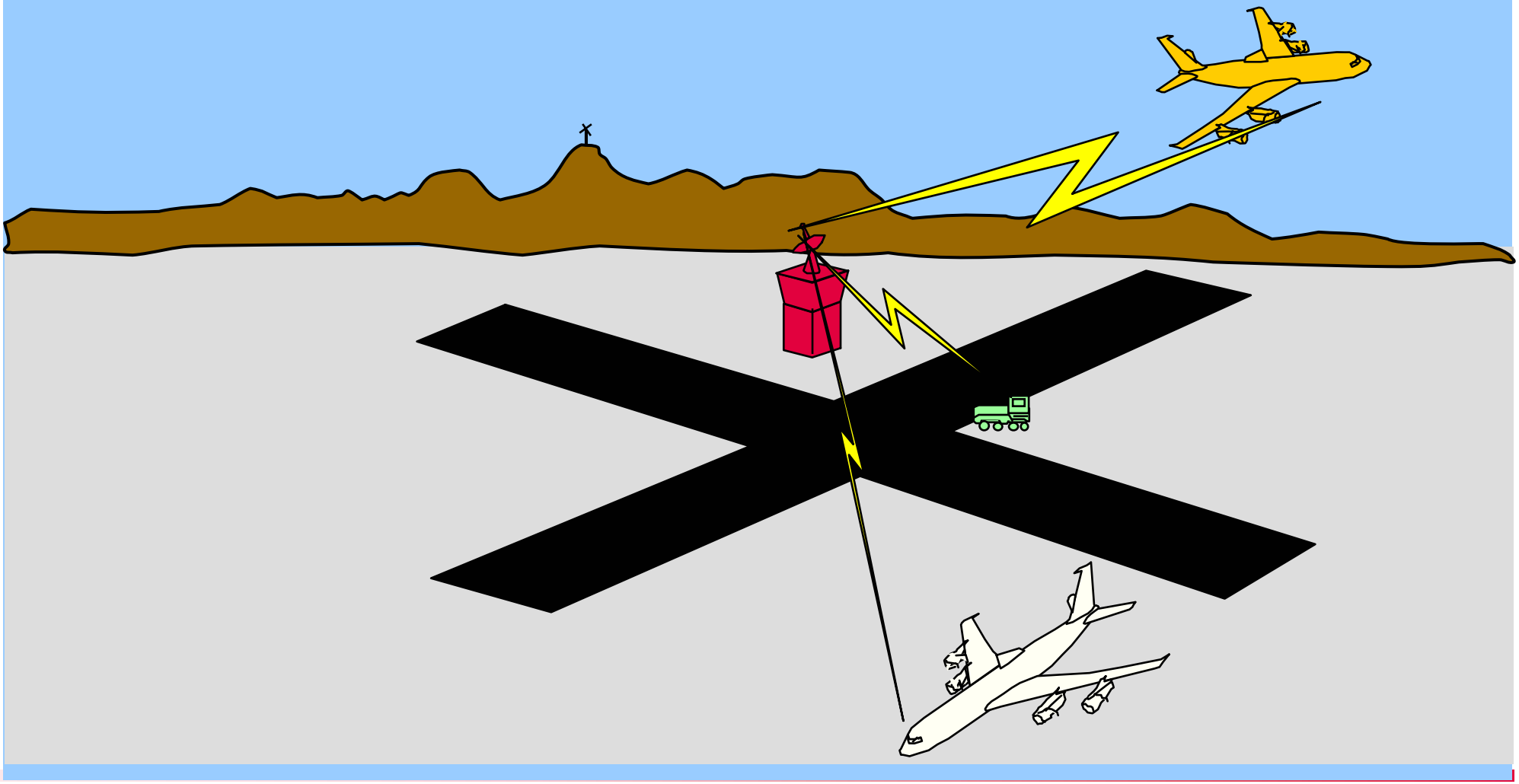
Need for Geometric Coherency between RF and Platforms



Test Philosophy For JCS

ViaSat
Government Systems

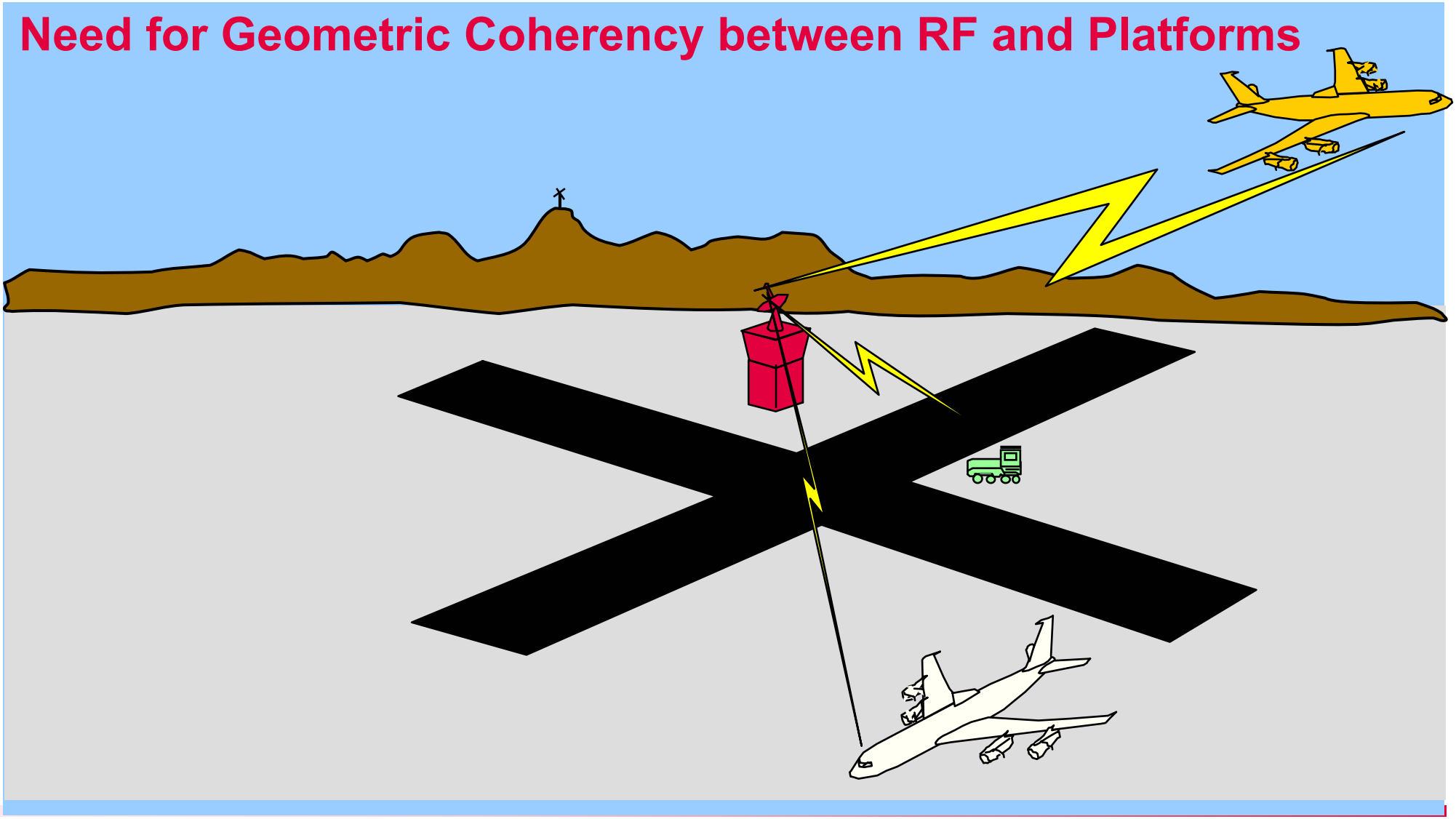
Need for Geometric Coherency between RF and Platforms



Test Philosophy For JCS

ViaSat
Government Systems

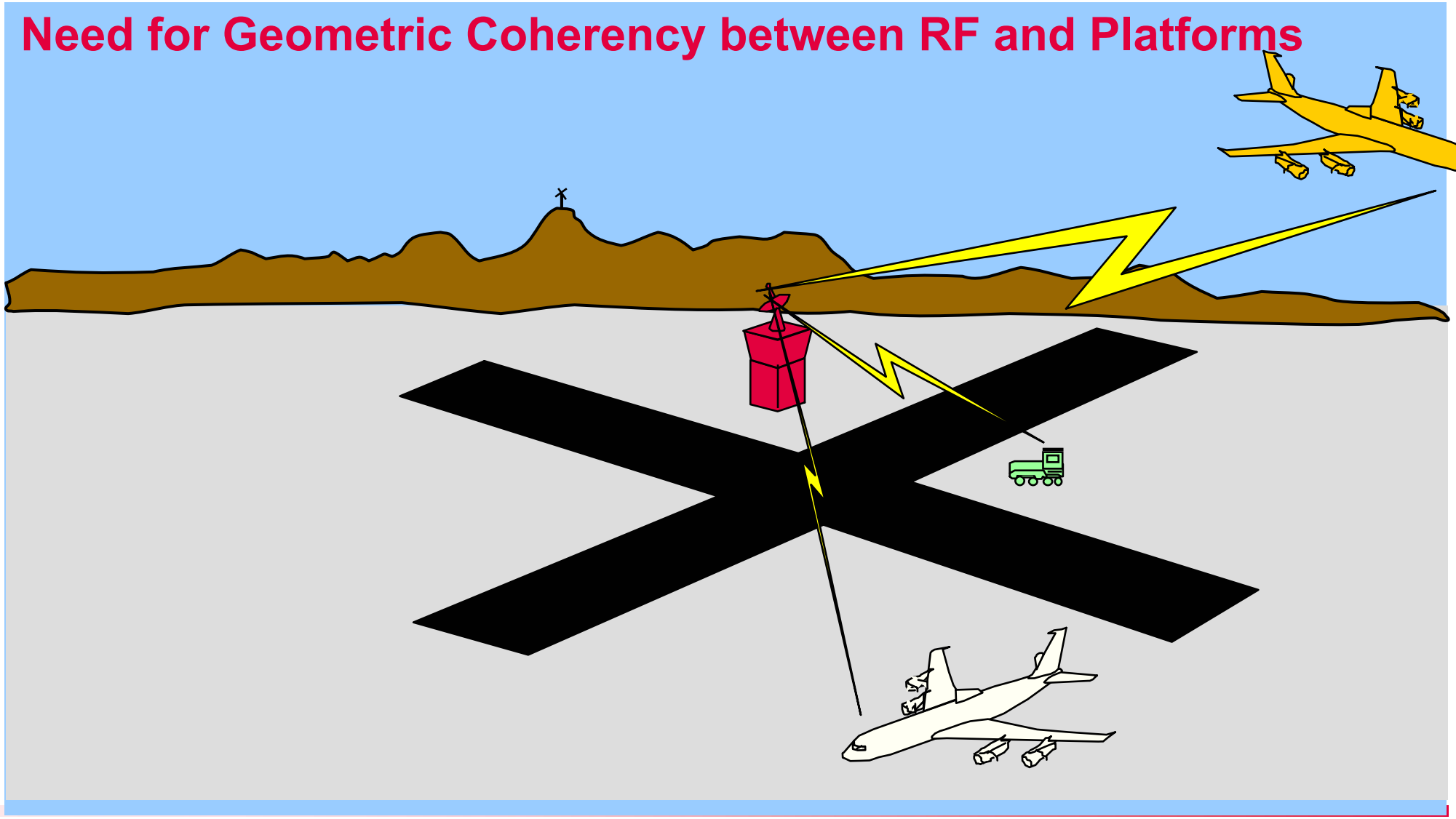
Need for Geometric Coherency between RF and Platforms



Test Philosophy For JCS

ViaSat
Government Systems

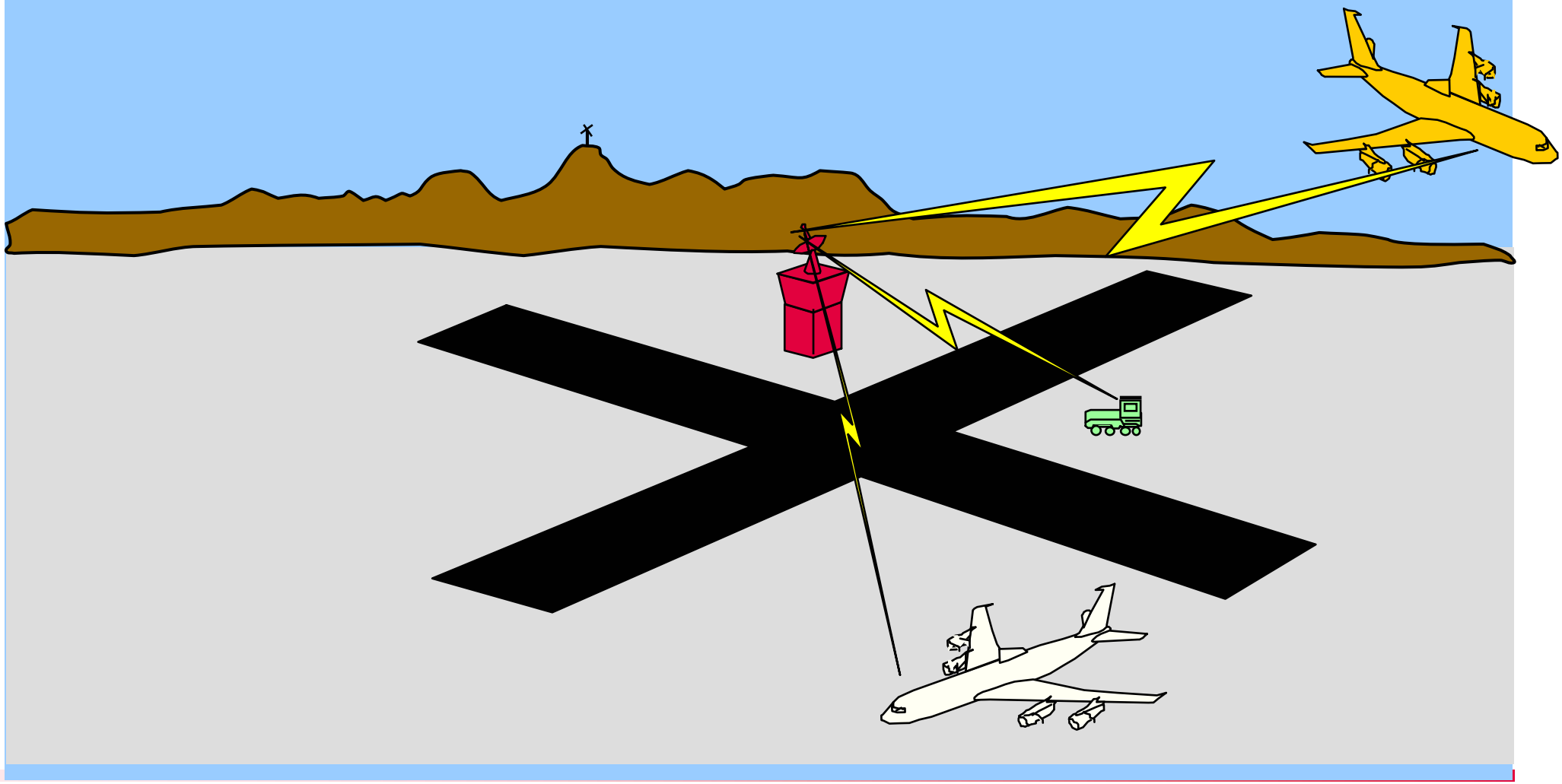
Need for Geometric Coherency between RF and Platforms



Test Philosophy For JCS

ViaSat
Government Systems

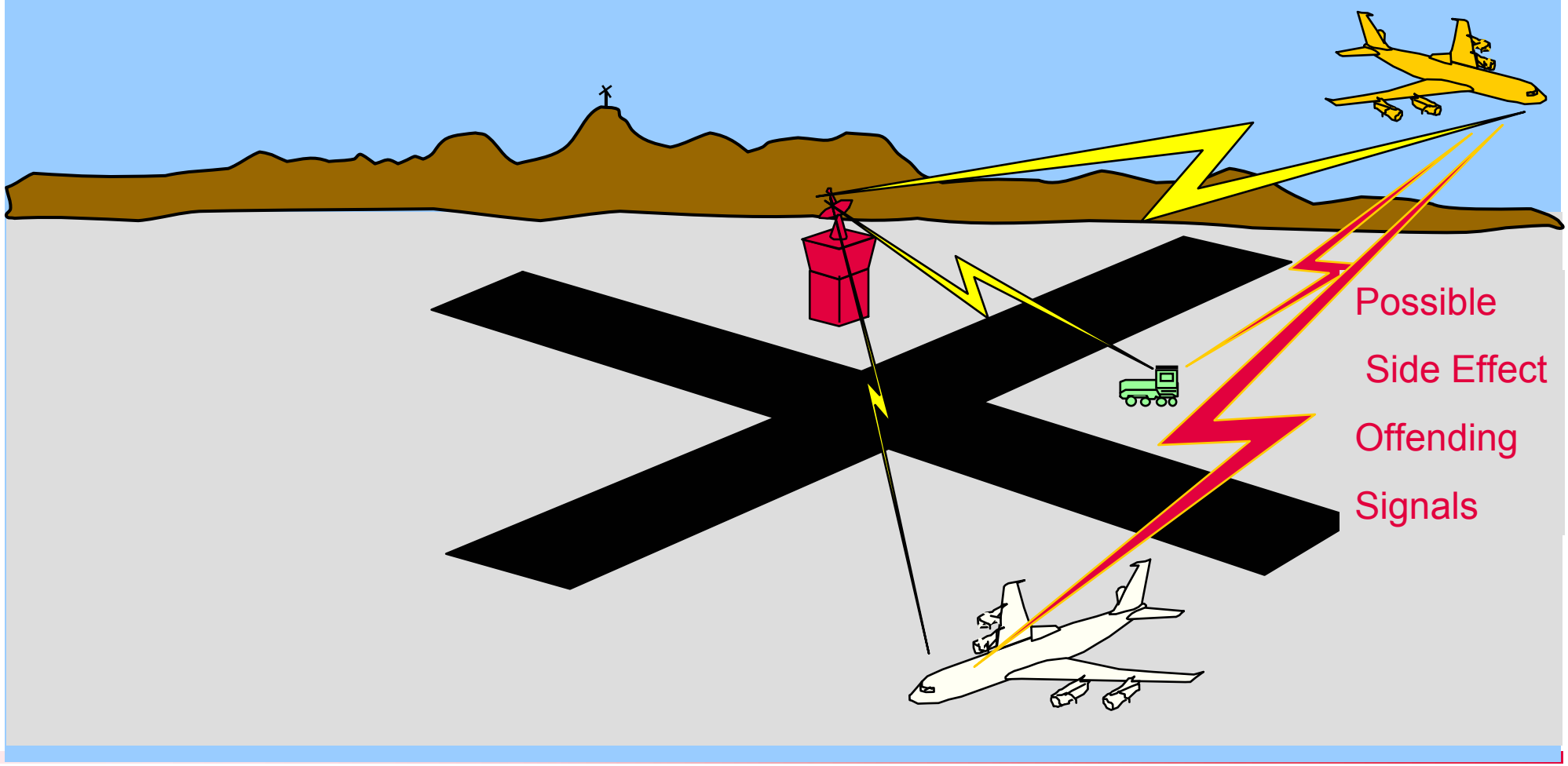
Need for Geometric Coherency between RF and Platforms



Test Philosophy For JCS

ViaSat
Government Systems

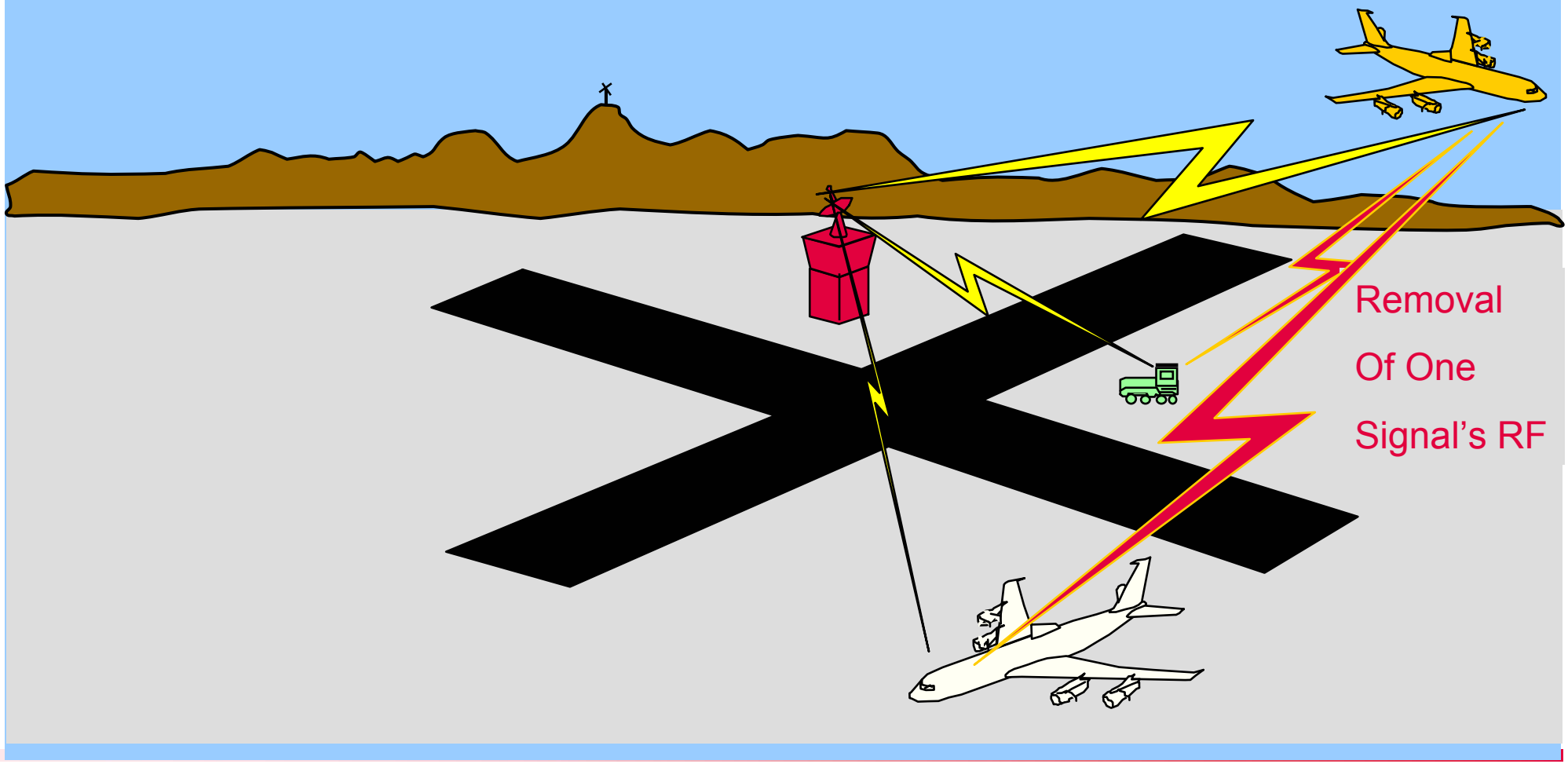
Need for Test Personnel to Affect Scenario in Real Time



Test Philosophy For JCS

ViaSat
Government Systems

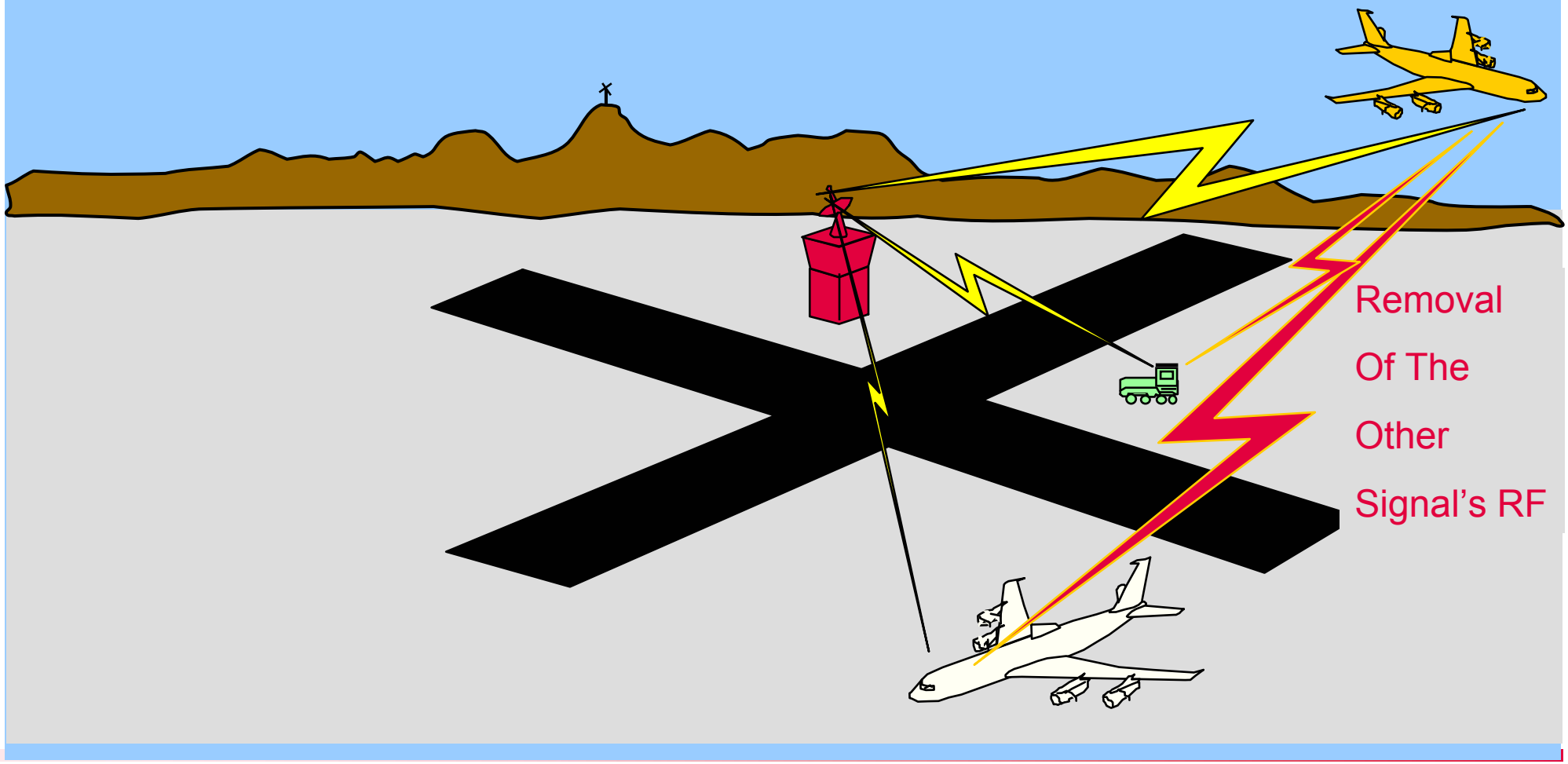
Need for Test Personnel to Affect Scenario in Real Time



Test Philosophy For JCS

ViaSat
Government Systems

Need for Test Personnel to Affect Scenario in Real Time



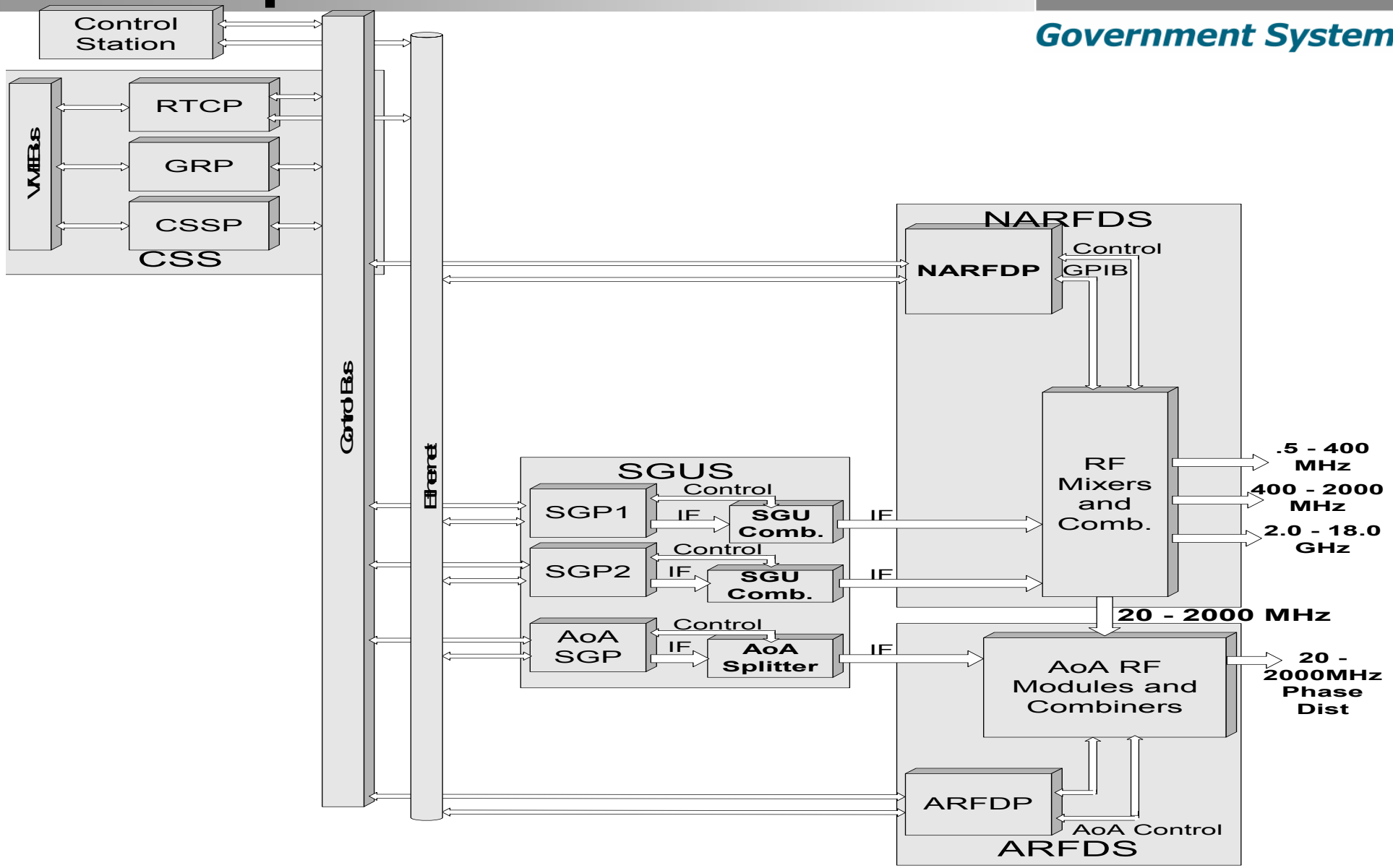
JCS Capabilities

ViaSat
Government Systems

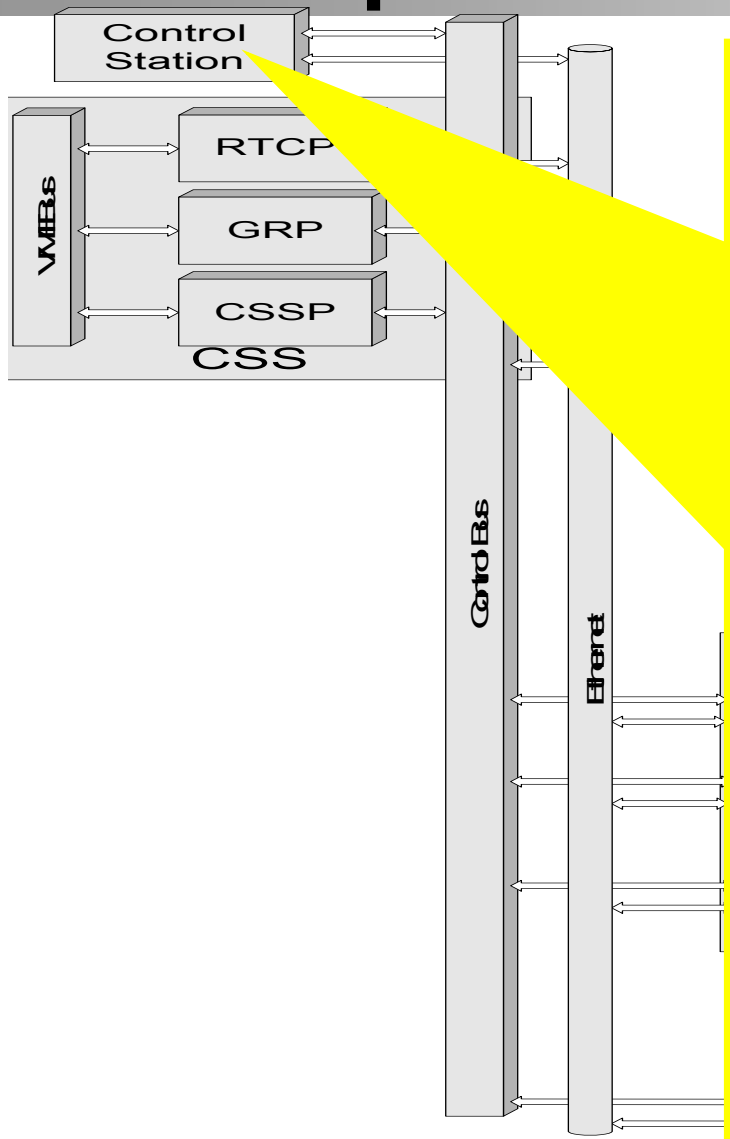
- **Highly Modular System Architecture To Support Incremental Research, Test and Development Needs**
- **Capable of Generating RF Signals with High Non-AoA and AoA fidelity.**
  - ***Non-AoA implies Amplitude and Time Fidelity***
  - ***AoA implies Amplitude, Time and Angle of Arrival Fidelity***
- **Arbitrary Waveform Generation Capability**
  - ***Analog Modulations include as examples AM, FM, SSB, ISB, DSB, Quadrature AM, FDM, and Double Modulation Techniques***
  - ***Digital Modulations include as examples BPSK, QPSK, OQPSK, DQPSK, QAM, 8-PSK, FSK, PPM***
  - ***10 Msym/sec Maximum Symbol Rate***
  - ***40 Msample/sec Maximum Sample Rate***
- **RF Generation between 500 KHz and 18 GHz**

JCS Top Level Architecture

ViaSat
Government Systems



JCS Top Level Architecture

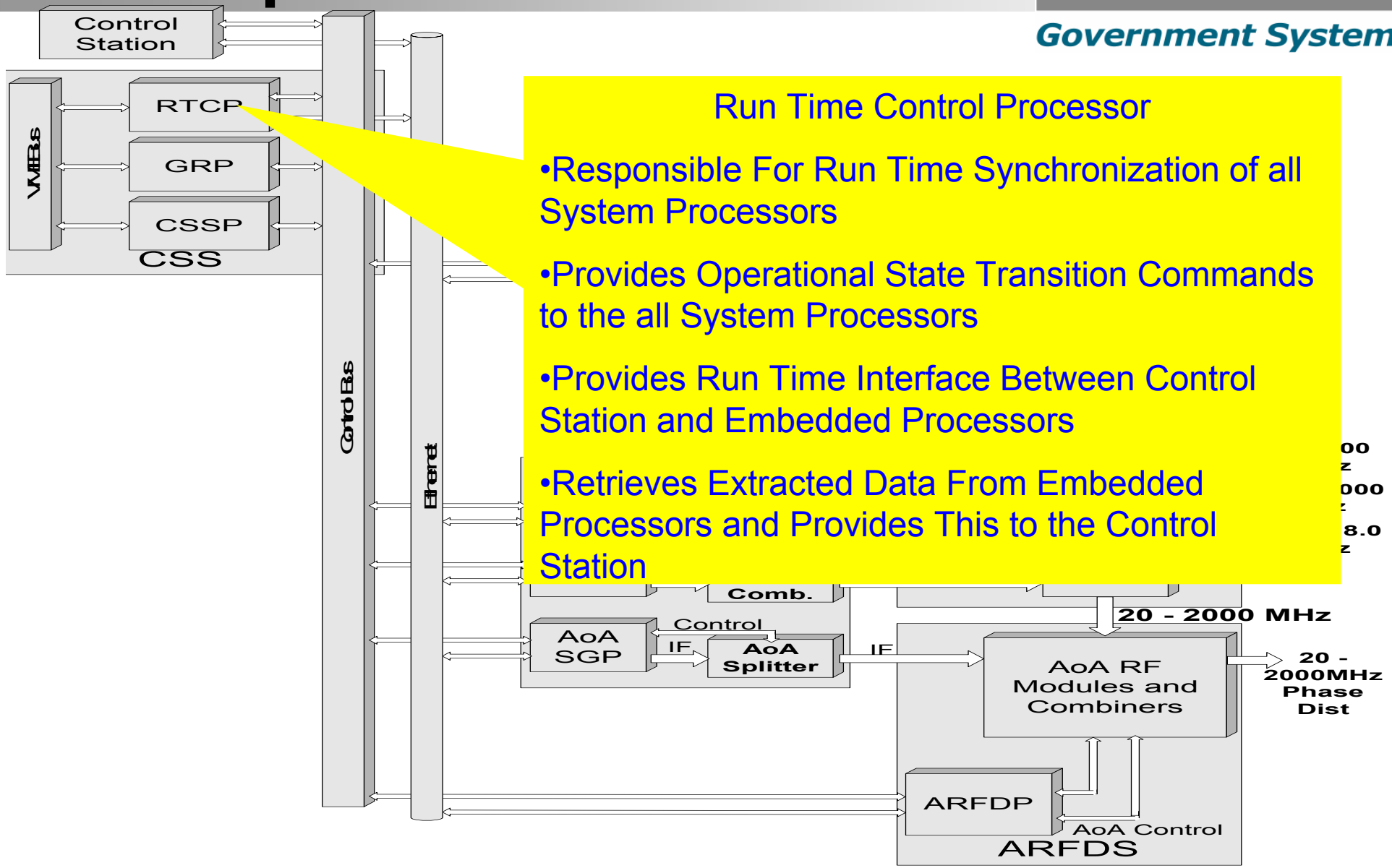


Control Station

- Graphical User Interface
- Define Emitter Modulation Parameter Values
- Define Platform Parameter Values
- Place Emitters on Platforms
- Place Platforms on a Map
- Place Virtual Counterpart to System Under Test (SUT) on a Map
- Assign Waypoints to Platforms
- Run a Scenario with Platforms
- Change Emitter and Platform Parameter Values in Real Time
- View Platform and Emitter Parameters of Interest as Seen by SUT during Run Time
- View Extracted Data After Scenario Terminates

JCS Top Level Architecture

ViaSat
Government Systems

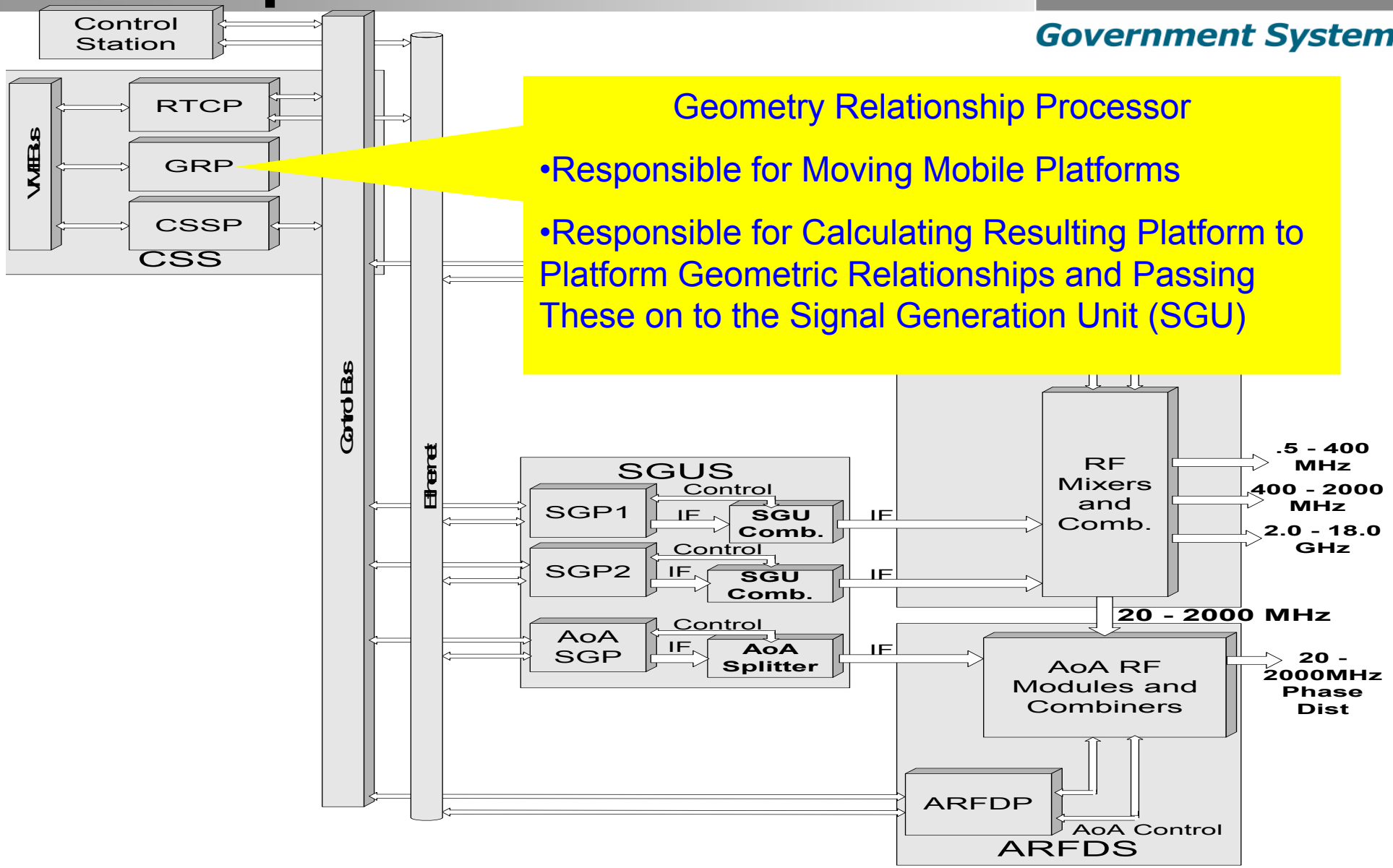


Run Time Control Processor

- Responsible For Run Time Synchronization of all System Processors
- Provides Operational State Transition Commands to the all System Processors
- Provides Run Time Interface Between Control Station and Embedded Processors
- Retrieves Extracted Data From Embedded Processors and Provides This to the Control Station

JCS Top Level Architecture

ViaSat
Government Systems

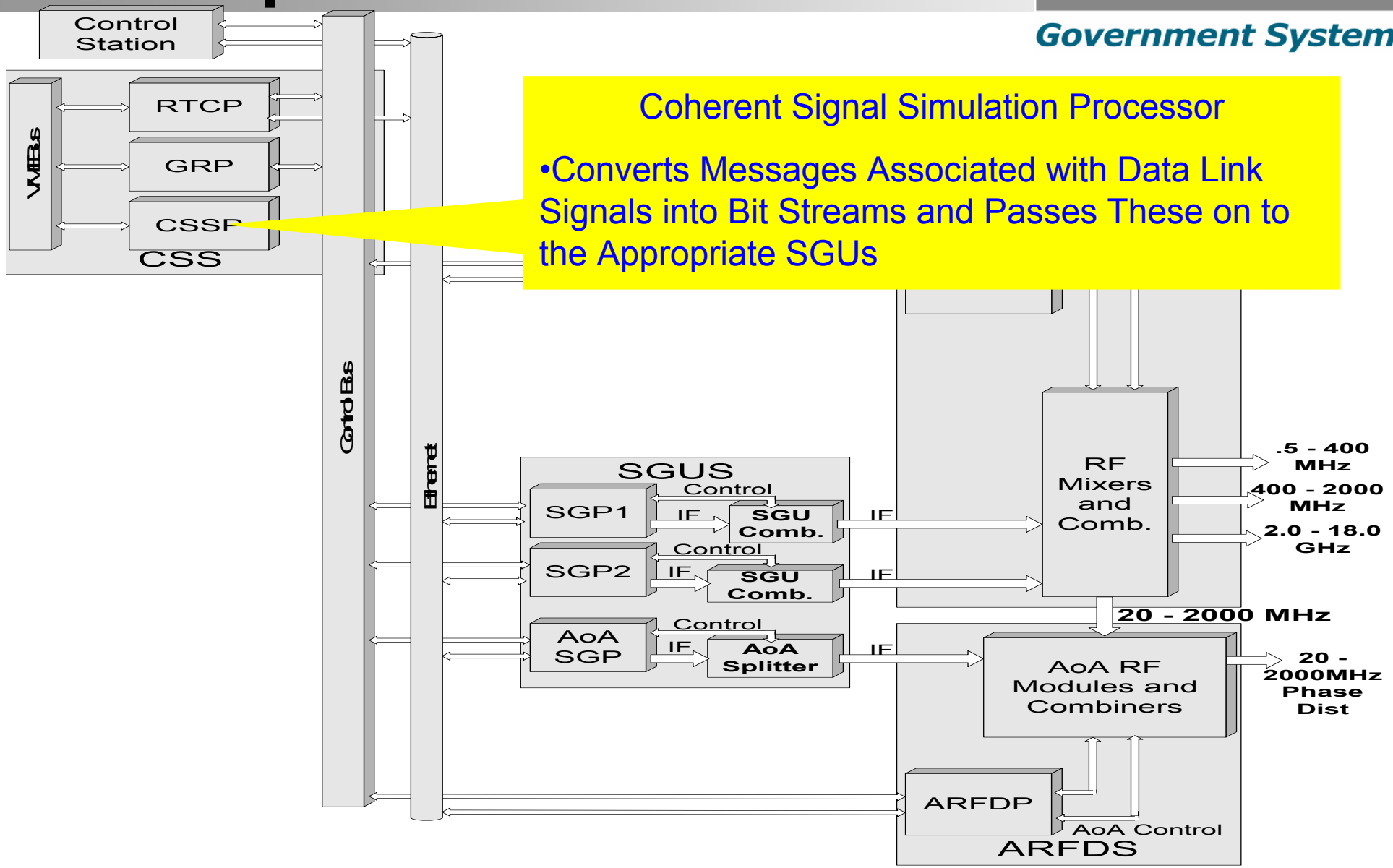


Geometry Relationship Processor

- Responsible for Moving Mobile Platforms
- Responsible for Calculating Resulting Platform to Platform Geometric Relationships and Passing These on to the Signal Generation Unit (SGU)

JCS Top Level Architecture

ViaSat
Government Systems

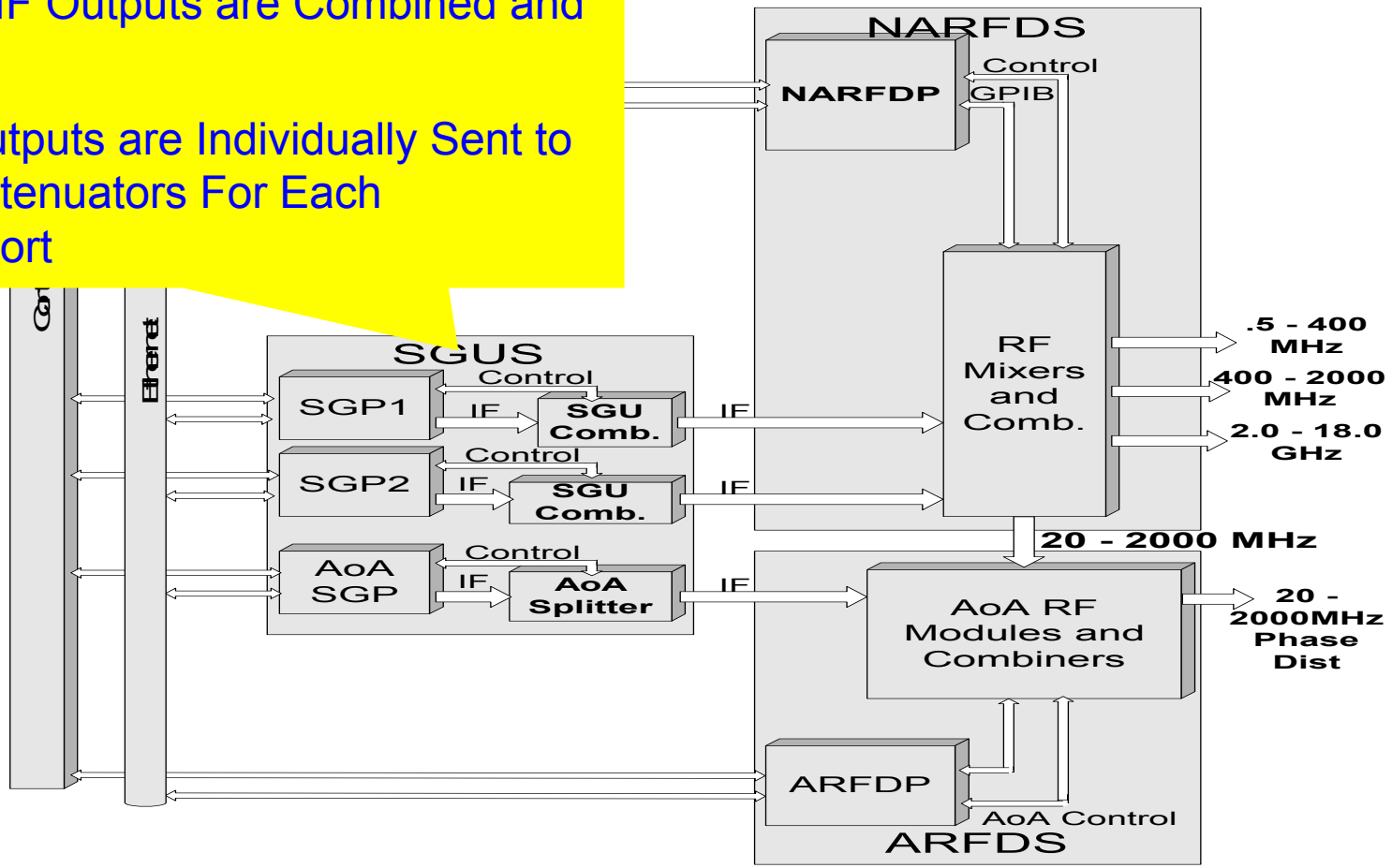


JCS Top Level Architecture

ViaSat Government Systems

Signal Generation Unit

- Consists of Multiple Signal Generation Processors (SGPs)
  - Non-AoA SGP IF Outputs are Combined and Fed to Mixers
  - AoA SGP IF Outputs are Individually Sent to Phase Shifter/Attenuators For Each Interferometer Port

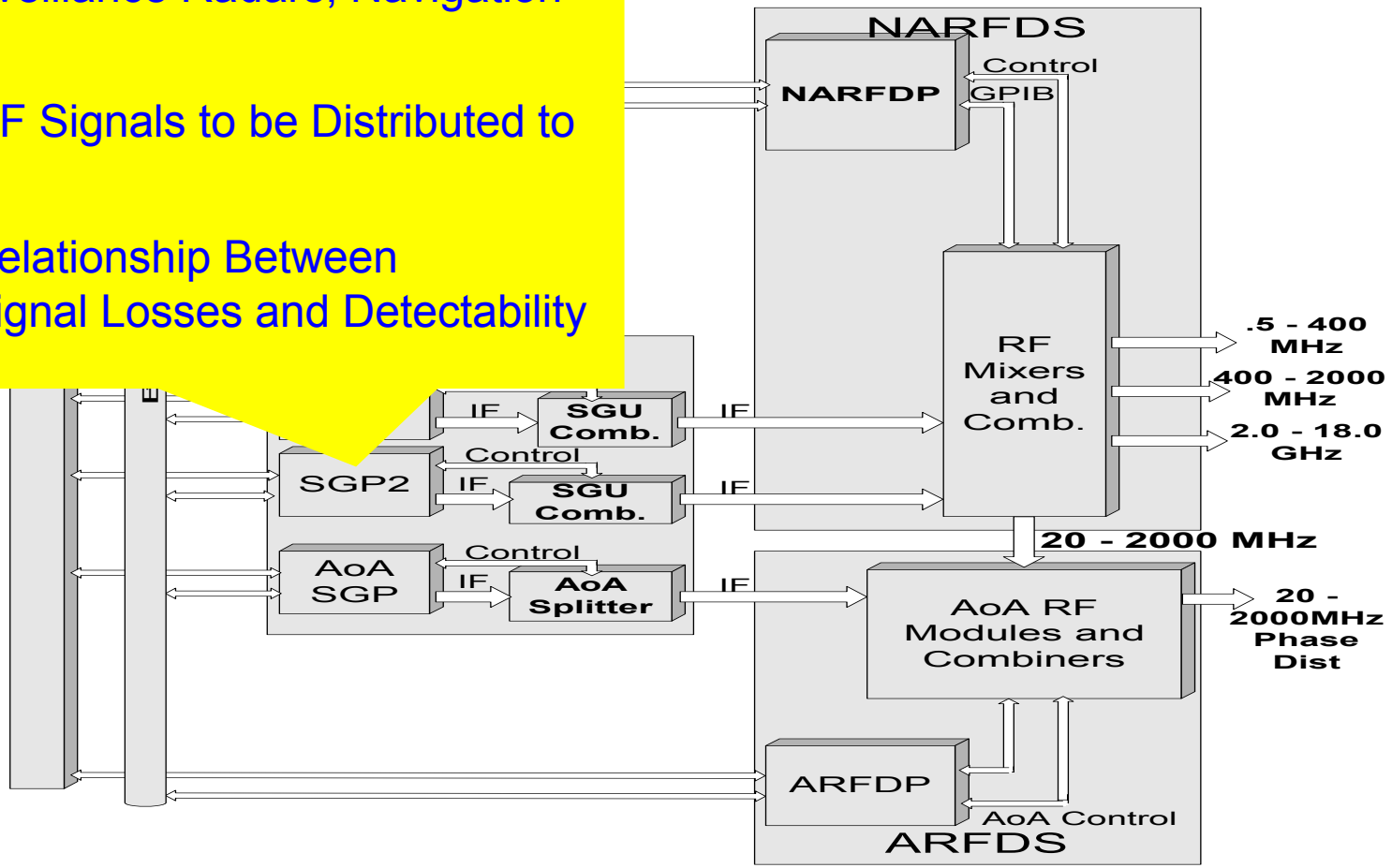


ture

ViaSat
Government Systems

Signal Generation Processor

- Consists of Multiple Processors and Arbitrary Waveform Generators
- Models Functionality of Systems such as IFF, Radars, Secondary Surveillance Radars, Navigation Instrumentation, … etc
- Generates Modulated IF Signals to be Distributed to the Non-AoA RF Mixers
- Based on Geometric Relationship Between Antennas, Calculates Signal Losses and Detectability

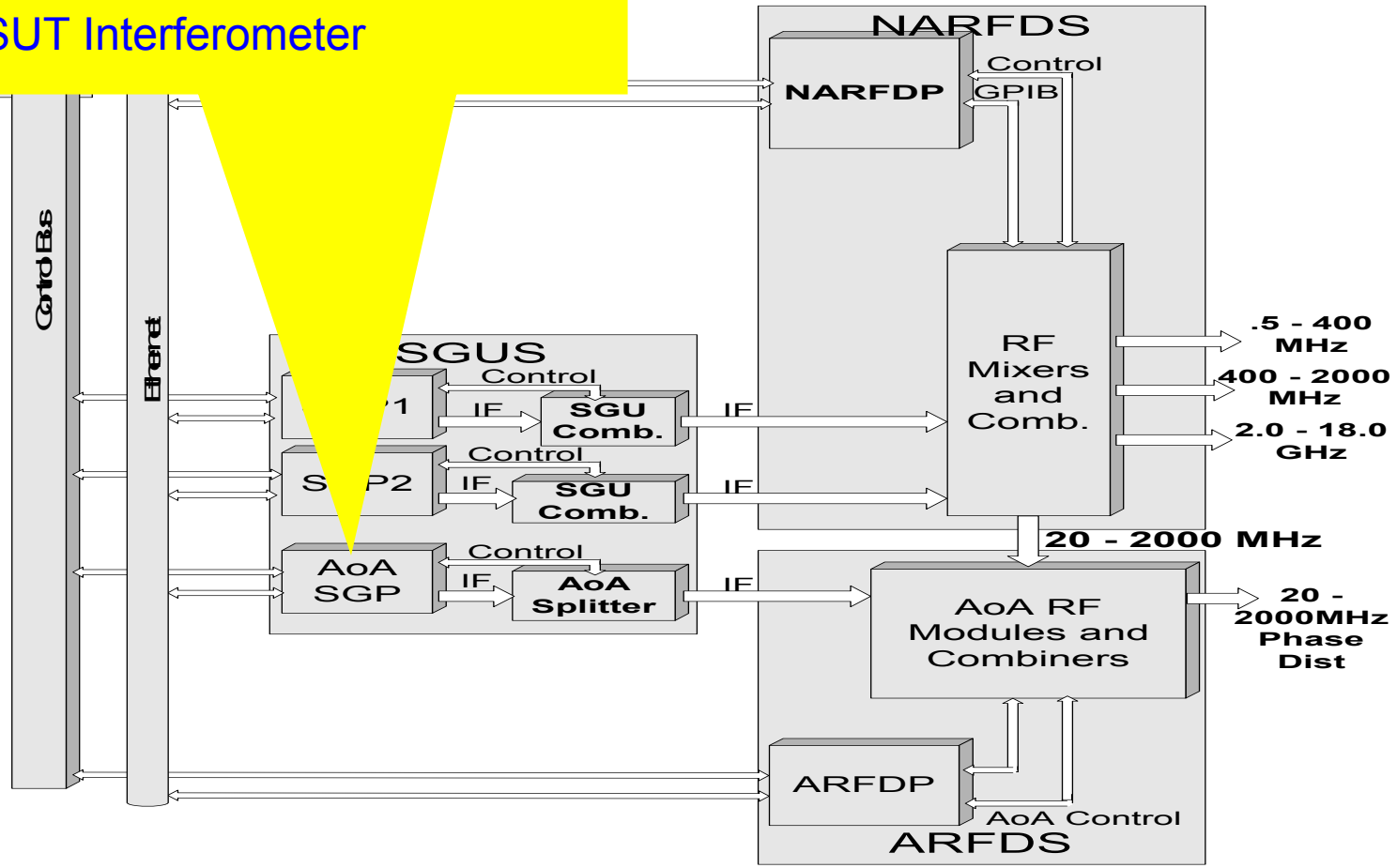


JCS Top Level Architecture

ViaSat
Government Systems

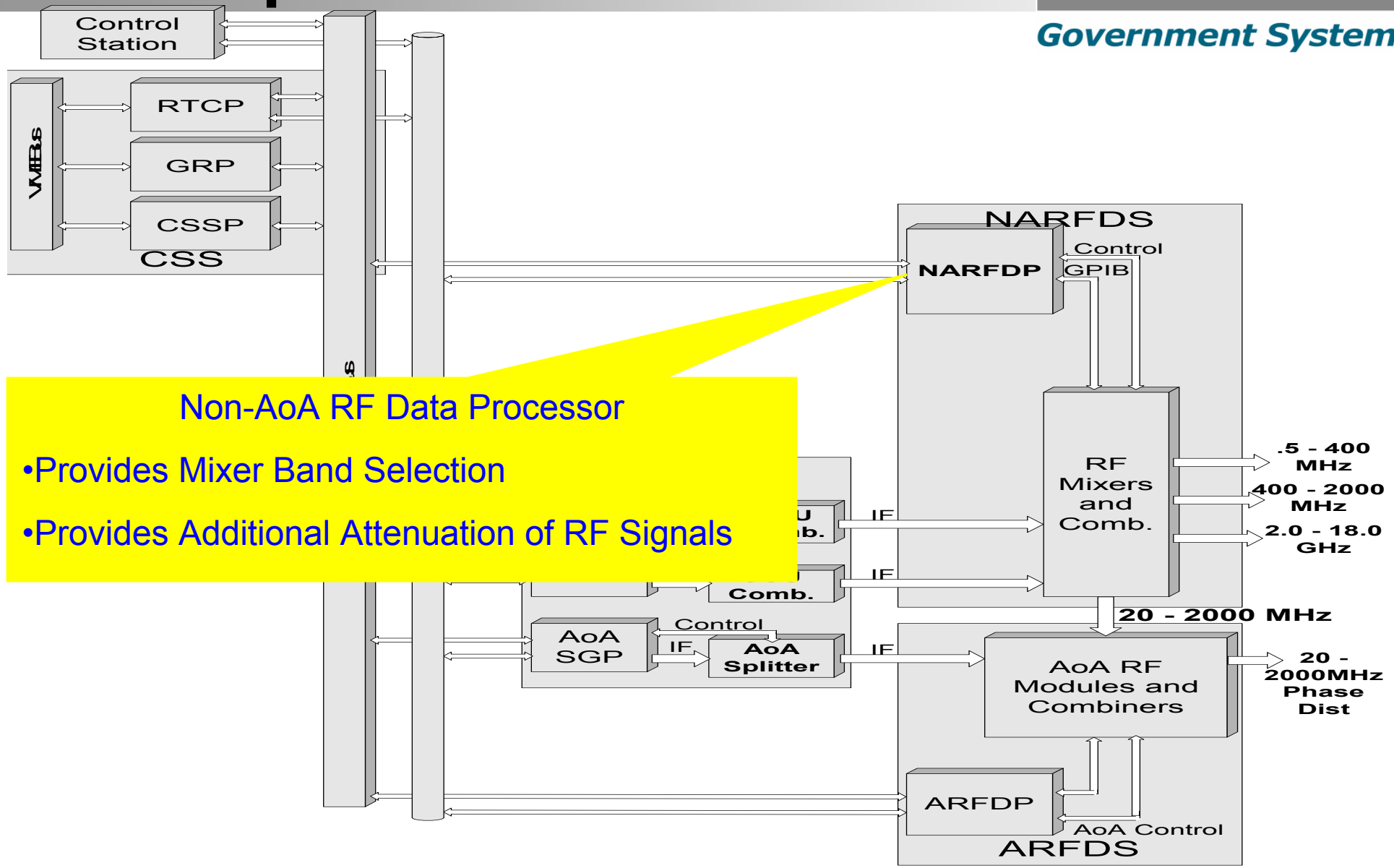
AoA Signal Generation Processor

- Same Model and Signal Processing As SGP
- Calculates Losses and Phase Shifts at Each Port Element of a SUT Interferometer



JCS Top Level Architecture

ViaSat
Government Systems

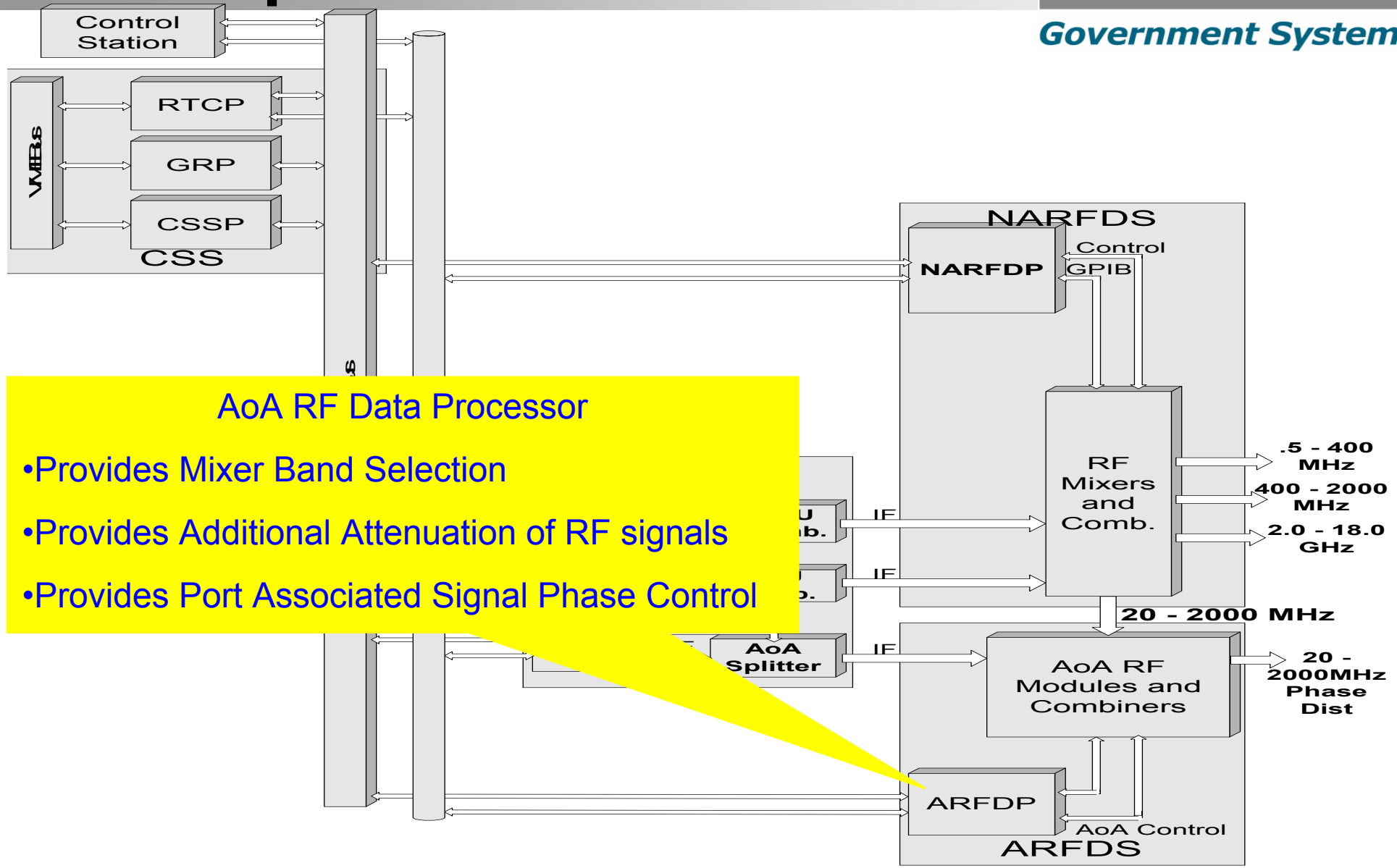


Non-AoA RF Data Processor

- Provides Mixer Band Selection
- Provides Additional Attenuation of RF Signals

JCS Top Level Architecture

ViaSat
Government Systems



AoA RF Data Processor

- Provides Mixer Band Selection
- Provides Additional Attenuation of RF signals
- Provides Port Associated Signal Phase Control

Current Enhancements

ViaSat
Government Systems

- Continuously Adding New Signals Per Customer Requests
- Adding State Machine Based Behavioral Modeling
  - *User Can write own behavioral model to drive JCS signals*
  - *Extends the functional modeling capability to include human-like decision making*
- Completing Development of Integrated Mode Operation
  - *Allows the JCS to be operated by a remote executive*
  - *Enables the JCS to operate synchronously with other simulators*
- Adding Digital Terrain Elevation Database (DTED)
  - *Allows signal propagation effects to include occlusion, diffraction and multipath effects*

Future Enhancements

ViaSat
Government Systems

- Add Library of Air Traffic Control Related Signals and Functional Models
- Add Library of Cellular signals and Functional Models
- Change the Form Factor of the Waveform Generators to PMC Daughter Cards
- Port the Control Station Software from the current SUN Workstation to a PC

Conclusion

ViaSat
Government Systems

- JCS Built with Flexibility, Signal Density and Test Personnel Control Primarily in Mind
- Capabilities of the JCS sufficient to model most CNS systems of interest
- JCS Architecture is built on an Embedded Real Time Synchronous Methodology allowing determinism and Hard Real Time Processing of Model Functionality and Signals
- Current and Future Enhancements aimed at continual increase in Fidelity to Real World CNS Systems